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Grenville Lake Area

District of Thunder Bay

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by G.P. Beakhouse

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Foreword

The Grenville Lake area includes the townships of Fulford, Kirby, and part of McQuesten in the Beardmore-Geraldton metavolcanic-metasedimentary belt. The area includes the northern contact of the metavolcanic-metasedimentary belt with the Onaman-Twin Lakes batholith. The mapping represents the near completion of detailed coverage of the belt, an important gold-producing area.

V.G. Milne
Director
Ontario Geological Survey

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GEOLOGICAL MAP (BACK POCKET)

Map 2513 (coloured)—Grenville Lake Area, District of Thunder Bay. Scale 1:31 680.

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS.

CONVERSION FROM SI TO IMPERIAL			CONVERSION FROM IMPERIAL TO SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.103 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight perton (short)	0.05	ounces (troy) per ton (short)

Note. Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in cooperation with the Coal Association of Canada.

Geology of the
Grenville Lake Area
District of Thunder Bay

G.P. Beakhouse

Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto.

Manuscript approved for publication by John Wood, Chief Geologist, June 12, 1984.
This report is published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Abstract

This report describes the geology and mineral deposits of the Grenville Lake area including Kirby, Fulford, and part of McQuesten Townships, located approximately 220 km northeast of the city of Thunder Bay. The map area is in the southern part of the Wabigoon Subprovince and straddles the northern contact of the Beardmore-Geraldton greenstone belt with the Onaman-Twin Lakes batholith.

All of the bedrock in the area, with the exception of Middle to Late Precambrian diabase dikes, is Early Precambrian in age. The metavolcanic-metasedimentary sequence of the greenstone belt is divisible into four eastward trending units that display contrasting lithologic characteristics. These are, from north to south the Kirby Lake metavolcanic unit, the Hutchison Lake metasedimentary unit, the Dionne Lake metavolcanic unit, and the Volcan Lake metasedimentary unit.

The Kirby Lake metavolcanics are characterized by a predominance of highly deformed, amphibolitic, mafic metavolcanics and a laterally persistent chert-magnetite ironstone unit. Felsic metavolcanics are rare. In the Dionne Lake metavolcanic unit, mafic metavolcanics predominate over the felsic variety but the latter is relatively abundant in the eastern part of the map area. Compared to those from the Kirby Lake unit, mafic metavolcanics from the Dionne Lake unit are less intensely deformed, have lower regional metamorphic grade, and are more intensely altered.

The Hutchison Lake metasedimentary unit consists of immature sandstone intercalated with ferruginous chemical sediments. The Volcan Lake metasedimentary unit includes polymictic conglomerate with subordinate sandstone. The clastic component of the Hutchison Lake unit is interpreted to have been deposited by turbidity flows in a basinal environment in which a "chemical rain" produced the ferruginous sediments. The Volcan Lake unit was deposited in a fluvial environment.

The Onaman-Twin Lakes batholith is subdivided into three phase groups viz., foliated granodiorite-tonalite, megacrystic granodiorite-granite, and equigranular granite. The latter two groups postdate the main regional deformation. A migmatitic zone in the batholith represents a fragmentary continuation of the Kirby Lake metavolcanic unit.

Relationships among the various units are not well defined due to extensive Pleistocene glacial deposits obscuring bedrock outcrop. At least one of the contacts (between the Hutchison Lake and Dionne Lake units) is a fault and by analogy with relationships elsewhere in the Beardmore-Geraldton belt it is concluded that the distinctive pattern of alternating, linear belts of metavolcanics and metasediments is a result of tectonic interleaving at the interface between a volcanic arc (Wabigoon Subprovince) and a sedimentary basin (Quetico Subprovince).

Continued exploration for both gold and base metals is recommended. The most favourable setting for gold mineralization appears to be veins and shears in altered mafic metavolcanics of the Dionne Lake metavolcanic unit. Minor production occurred from the Gulch Resources Limited (15) property in the 1940s. The potential for base metal mineralization of a laterally persistent ironstone horizon in the Kirby Lake unit and felsic metavolcanics from the Dionne Lake unit should be further evaluated.

Geology of the Grenville Lake Area, District of Thunder Bay, by G.P. Beakhouse, Ontario Geological Survey Report 246, 75p. Accompanied by Map 2513, scale 1:31 680. Published 1989. ISBN 0-7729-1036-7.

Résumé

Ce rapport décrit la formation géologique et les gisements minéraux de la région du lac Grenville, y compris les cantons de Kirby, Fulford et une partie du canton de McQuesten, situés à environ 220 km au nord-est de la ville de Thunder Bay. La région représentée sur la carte se trouve dans la partie sud de la sous-province de Wabigoon et enjambe la surface de contact nord de la ceinture de roches vertes de Beardmore-Geraldton et le batholite des lacs Onaman-Twin.

L'ensemble du socle rocheux de la région, à l'exception des dykes de diabase du précambrien moyen à supérieur, date du précambrien inférieur. La série de roches métavolcaniques-métasedimentaires de la ceinture de roches vertes se divise en quatre unités orientées vers l'est présentant des caractéristiques pétrographiques contrastées. Il s'agit, du nord au sud, de l'unité métavolcanique du lac Kirby, de l'unité métasédimentaire du lac Hutchison, de l'unité métavolcanique de lac Dionne et de l'unité métasédimentiare du lac Volcan.

Les roches métavolcaniques du lac Kirby sont caractérisées par la prédominance de roches métavolcaniques mafiques à amphiboles et très déformées, et par une unité de minerai de fer en chert-magnétite à persistance latérale. Les roches métavolcaniques felsiques sont rares. Dans l'unité métavolcaniques du lac Dionne, les roches métavolcaniques mafiques sont plus nombreuses que la variété felsique, par contre cette dernière est relativement abondante dans la partie est de la région représentée par la carte. Comparées aux roches provenant de l'unité du lac Kirby, les roches métavolcaniques mafiques de l'unité du lac Dionne sont moins profondément déformées, ont une plus faible teneur métamorphique régionale et ont subi des transformations plus importantes.

L'unité métasédimentaire du lac Hutchison se compoes de grès immature intercalé avec des sédiments chimiques ferrugineux. L'unité métasédimentaire du lac Volcan comprend un conglomérat polygénique formé de grès secondaire. On pense que la composante clastuqe de l'unité de lac Hutchison a été déposée par des coulées de turbidité dans un environnement du type bassin dans lequel des "pluies acides" ont formé des sédiments ferrugineux. L'unité du lac Volcan a été déposée dans un environnement fluvial.

Le batholite des lacs Onaman-Twin est subdivisé en trois groupes à phases : granodiorite-tonalite feuilletée, granodiorite-granit mégacrystique et granit isogranulaire. Les deux derniers groupes sont postérieurs à la principale déformation régionale. La présence d'une zone migmatitique dans le batholite est une continuation fragmentaire de l'unité métavolcanique du lac Kirby.

Les rapports entre les différentes unités ne sont pas bien définies en raison des importants dépôts galciaires du pléistocène qui dissimulent l'affeurement du socle rocheux. Une des surfaces de contact au moins (située entre les unités des lacs Hutchison et Dionne) est une faille et on a conclu, par analogie avec les autres rapports existant dans la ceinture de Beardmore-Geraldton, que la structure particulière des ceintures linéaires alternantes de roches métavolcaniques et métasédimentaires provenait d'une interfolation tectonique à l'interface entre un arc volcanique (la sous-province de Wabigoon) et un bassin sédimentaire (la sous-province de Quetico).

On recommande de continuer la prospection de l'or et des minerais pauvres. Les emplacements les plus favorables à la minéralisatin aurifère semblent être les filons et les fractures des roches métavolcaniques mafiques de l'unité métavolcanique du lac Dionne. Dans les années 1940, la propriété de Gulch Resources Limited (15) a peu produit. Il faudrait réévaluer les possibilités en matière de minéralisation des minerais pauvres d'un environnement de minerai de fer à persistance latérale dans l'unité du lac Kirby et les roches felsiques de l'unité du lac Dionne.

Introduction

The map area is located in the District of Thunder Bay, 3 km north of the Town of Geraldton and approximately 220 km northeast of the City of Thunder Bay. The map area covers approximately 230 km^2 and includes Kirby, Fulford, and part of McQuesten Townships. The area is bounded by 49°50′21″N and 49°45′09″N Latitudes and 86°53′02″W and 87°13′08″W Longitudes.

Access

Highway 584 and a Kimberly-Clark logging road (referred to locally as the Greta Lake road) extend through the eastern part of the map area. Much of Fulford and McQuesten Townships is accessible from abandoned logging roads although washouts and overgrowth limit the use of vehicles on some of these roads. The southeastern part of Kirby Township is also accessible from abandoned logging roads via the Wildgoose Beach road which intersects the Trans-Canada Highway approximately 14 km west of Geraldton. A Trans-Canada natural gas pipeline road provides access to the south-central part of McQuesten Township. The northern and western parts of Kirby Township are not accessible by road and lakes are too small for fixed-wing aircraft to land. Access to these areas was by helicopter.

Topography and Drainage

The map area is divisible into two physiographically distinct regions, the boundary between which is approximately defined by a line trending east-northeastward and passing through Kirby and Fulford Lakes. To the north of this line, the elevation ranges from 1200 to 1400 feet whereas to the south the elevation is from less than 1100 feet to 1200 feet. Extensive Pleistocene sand deposits and subdued local relief (generally less than 15 m) characterizes the southern area. Local relief in this area in excess of 15 m is generally related to drumlinoid ridges, eskers, or outcrops of diabase. The northern area is characterized by more rugged topography with relatively abundant bedrock ridges and incised creeks resulting in local relief of up to 50 m.

The height-of-land between the Arctic and Atlantic watersheds passes through the map area, lying near the Kirby-Fulford Township line in the southern part of the map area and then extending in a northeastward direction through the northwestern part of Fulford Township. To the west of the height-of-land, the area is drained by Wildgoose and Dumas Creeks which flow into the Namewaminikan (Sturgeon) River which discharges into Lake Nipigon. To the east, the area is drained by the Burrows River which empties into the Kenogamisis River to the northeast of the map area and ultimately into Hudson Bay.

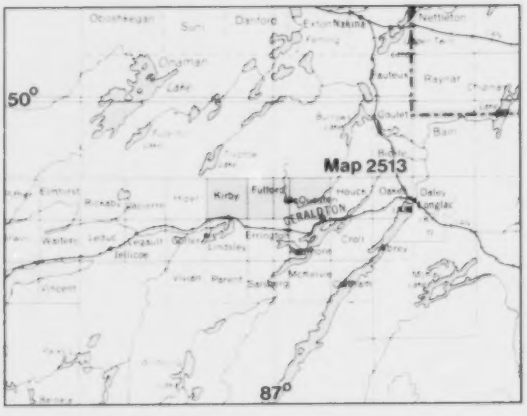

Figure 1. *Key map showing the location of the Grenville Lake Area. Scale 1:1 584 000.*

Previous Work

Several early workers investigated the Little Long Lac (Kenogamisis Lake) area south of the present map area but A.G. Burrows (1917) was evidently the first worker to examine outcrops in the map area of this report. He examined outcrops along the Upper Devilfish (now Burrows) River and the shoreline of Hutchison Lake. The only outcrops he described are schists with quartz veins from which he (Burrows 1917, p.244) reported gold assays of "80 cents per ton" (approximately 0.04 ounces/ton). He described these outcrops as being on the north shore of Hutchison Lake but the map accompanying his report shows outcrop only on the south shore of the lake, in keeping with the results of the present survey.

The first semi-detailed mapping of the area was by R.D. Macdonald (1943) who investigated Kirby, Fulford, McQuesten, and Houck Townships. The distribution of outcrop and the major lithologic units outlined by him agree well with those outlined by the present survey.

The townships to the south of the map area have been mapped by E.L. Bruce (1935), E.G. Pye (1952), and H.C. Horwood and E.G. Pye (1955). These authors examined some outcrops in the extreme southern part of the map area. W.O. Mackasey (1974) described the geology of the area to the west of the map area.

Aspects of the surficial geology of the area have been discussed by J.F. Gartner (1979).

There are federal-provincial aeromagnetic maps for the area at a scale of 1:25 000 (Ontario Division of Mines-Geological Survey of Canada 1974a,b,c,d)

Present Survey

Field work for this report was carried out during the summer of 1982. Pace-and-compass traverses were run at right angles to regional strike between topographical features visible on vertical aerial photographs. Traverse spacing was approximately 400 m except for those areas where aerial photographic interpretation and direct aerial reconnaissance from helicopter suggested no outcrops were present. Traverses run at 1000 m intervals in these latter areas confirmed that no or very few, small outcrops are present in areas of extensive Pleistocene cover. Traverses were supplemented by examination of shoreline and roadside outcrops.

Field data were recorded on transparent acetate overlays on vertical aerial photographs (scale: 1:15 840). This information was transferred to cronaflex base maps at the same scale. Uncoloured preliminary maps were published in 1983 (Beakhouse and Chevalier 1983a,b).

Acknowledgments

The author was capably assisted in the field by P.J.M. Chevalier, J.R. Devaney, I.D. MacMillan, and D.R. Walker. Mr. Chevalier, acting as senior assistant, mapped approximately one half of the area. Mr. Devaney ran several independent traverses during the latter half of the summer and some of the results of his B.Sc. research on the conglomerates at Volcan Lake have been incorporated in this report. Figure 11 is largely based on his observation.

J.K. Mason, C.D. McConnell, and G.C. Patterson (all from the Resident Geologist's Office, Ministry of Northern Development and Mines, Thunder Bay), and P.C. Thurston and J. Wood (both from the Ontario Geological Survey, Toronto) visited the author in the field and provided much valuable information and stimulating discussion. Heather Brown (Resident Geologist's Office, Ministry of Northern Development and Mines, Thunder Bay) researched the ownership of several of the properties and occurrences in the area.

Mr. Earl Stone (Geraldton District Manager) and the staff at the Ministry of Natural Resources district office and district fire centre provided cheerful and able accounting and logistic support during the field season.

Joseph Oster and Thorwald Johanson, local prospectors in the Geraldton area, provided valuable information on mineral occurrences and access.

General Geology

The map area straddles the northern contact of the Beardmore-Geraldton metavolcanic-metasedimentary belt with the Onaman-Twin Lake batholithic complex. The bedrock in this area is inferred to be mainly Early Precambrian in age (Table 1) by analogy with similar rocks elsewhere in the Superior Province. No modern geochronological investigations have been carried out in the Beardmore-Geraldton area.

The Beardmore-Geraldton belt is located in the southern part of the Wabigoon Subprovince adjacent to the Quetico Subprovince. The alternation of linear metavolcanic and metasedimentary units and paucity of internal felsic intrusive rocks that characterizes this belt (Pye *et al.* 1966) contrasts sharply with that of most other Wabigoon Subprovince greenstone belts. The Onaman-Tashota greenstone belt, to the north of the Beardmore-Geraldton greenstone belt, is more typical with predominantly volcanic sequences deformed into arcuate belts with intervening felsic plutonic rocks.

The distribution of lithologies in the map area reflects the distinctive structural style of the entire Beardmore-Geraldton belt and the rocks in the area can be conveniently described in terms of five eastward trending belts of distinctive lithologic assemblages. These are referred to informally as, from south to north, the Volcan Lake metasediments, the Dionne Lake metavolcanics, the Hutchison Lake metasediments, the Kirby Lake metavolcanics, and the Onaman-Twin Lakes batholith. The generalized distribution of these units and their relationship to the larger structure of the Beardmore-Geraldton greenstone belt are illustrated in Figure 2. The relative age relationships among these units are not known due to limited outcrop, paucity of reliable facing indicators in the metavolcanics, and structural complexities.

Mafic metavolcanic rocks predominate in the Dionne Lake metavolcanics but felsic metavolcanic rocks are relatively abundant in the eastern part of the unit. Minor amounts of clastic and chemical metasediments are interlayered with the metavolcanics.

Mafic metavolcanic rocks predominate in the Kirby Lake metavolcanics and only very minor felsic metavolcanic rocks are present in the western part of McQuesten Township. A laterally persistent banded ironstone extends from central Kirby Township to the northeastern part of McQuesten Township and thin interflow ironstone and chert units are common in the mafic metavolcanics near the main ironstone unit.

The lithologic and sedimentological characteristics of the two metasedimentary units contrast sharply. Massive to medium-bedded, polymictic conglomerate with subordinate feldspathic to lithic arenite characterize the Volcan Lake metasediments. Coarse clastic deposits do not occur in the Hutchison Lake metasediments where turbiditic wacke is interlayered with minor chloritic schist and magnetite layers.

The granitoid rocks of the Onaman-Twin Lakes batholithic complex are subdivided into three groups of phases based on contrasting textural, compositional, and structural characteristics. These three groups are, in order of decreasing relative age: foliated, equigranular tonalite-granodiorite; megacrystic granodiorite-granite; and equigranular granite.

All of the aforementioned rock types are cut by diabase dikes interpreted to be Proterozoic in age. Extensive Pleistocene glaciofluvial deposits cover the bedrock throughout much of the area.

The structure of the early Precambrian rocks is not well understood due to the nature and limited extent of bedrock exposures. Only in the western part of the outcrop area of the Hutchison Lake metasediments are reliable facing indicators sufficiently numerous to delineate the presence of a major fold structure. The synclinal axial trace of this fold is assymmetrically disposed towards the southern margin of the Hutchison Lake metasediments where a fault contact with the Dionne Lake metavolcanics is inferred. The scant available evidence in the other supracrustal rocks suggest they face towards this synclinal axis.

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR THE GRENVILLE LAKE AREA.

PHANEROZOIC

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT
Sand, gravel and lake, stream and swamp deposits

Unconformity

PRECAMBRIAN

LATE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS
Equigranular diabase, porphyritic diabase (plagioclase phenocrysts)

Intrusive Contact

EARLY PRECAMBRIAN

EQUIGRANULAR, POSTTECTONIC FELSIC PLUTONIC ROCKS
Massive granite, foliated biotite granite, massive granodiorite, foliated biotite granodiorite, massive tonalite, foliated biotite tonalite, leuco-pegmatite, biotite pegmatite, aplite

Intrusive Contact

MEGACRYSTIC, POSTTECTONIC FELSIC PLUTONIC ROCKS
Massive, megacrystic biotite granodiorite to granite, foliated megacrystic biotite granodiorite to granite

Intrusive Contact

PRETECTONIC AND SYNTECTONIC FELSIC PLUTONIC ROCKS
Foliated biotite tonalite to granodiorite, biotite tonalite to granodiorite with ribbon quartz, lineated biotite tonalite to granodiorite, porphyritic foliated biotite tonalite to granodiorite

Intrusive Contact

MAFIC INTRUSIVE ROCKS
Gabbro (fine, medium, and coarse grained)

Intrusive Contact

METASEDIMENTS AND METAVOLCANICS

METASEDIMENTS

CHEMICAL METASEDIMENTS
Chert, magnetite-hematite-chert ironstone, magnetite layers

CLASTIC METASEDIMENTS
Laminated to thinly bedded wacke, medium-bedded wacke, thickly bedded to massive wacke, polymictic clast-supported conglomerate, polymictic matrix-supported conglomerate, pebbly arkose, thickly to massively bedded arkose, thinly to medium-bedded arkose

METAVOLCANICS

INTERMEDIATE TO FELSIC METAVOLCANICS
Tuff-breccia, massive tuff, thinly- to medium-bedded tuff, lapilli-tuff, carbonatized tuff, quartz-feldspar porphyry, feldspar porphyry, felsite dikes

MAFIC TO INTERMEDIATE METAVOLCANICS
Massive flows, pillowed flows, pillow breccia, hyaloclastite breccia, porphyritic flow, medium-grained flow, altered mafic flow, amphibolitic inclusions in felsic plutonic rocks.

EARLY PRECAMBRIAN

METAVOLCANICS

Metavolcanics occur in two principal outcrop areas, the Dionne Lake metavolcanics and the Kirby Lake metavolcanics to the south and north, respectively, of the Hutchison Lake metasediments (Figure 2).

Mafic metavolcanic rocks predominate in the Dionne Lake metavolcanics. Felsic metavolcanic rocks are interlayered on a large scale with the mafic metavolcanics in the eastern part of the unit. Interflow and interpillow cherty metasediments are rare. Clastic metasediments and sulphide-rich magnetic ironstone are interpreted to be present on the basis of a diamond-drill hole log and aeromagnetic anomaly at the east end of Dionne Lake along a mafic-felsic contact.

Mafic metavolcanic rocks predominate in the Kirby Lake metavolcanics. Minor felsic metavolcanic rocks within this unit are restricted to the western part of McQuesten Township. Cherty and ferruginous chemical metasediments are conspicuously interlayered with the mafic metavolcanics for the entire length of the unit. Amphibolitic inclusions in the Onaman-Twin Lakes batholith in northeastern Kirby Township and northwestern Fulford Township are correlative with the Kirby Lake mafic metavolcanics and represent a fragmentary continuation of this unit.

Dionne Lake Mafic Metavolcanics

Mafic metavolcanic rocks in the Dionne Lake metavolcanics include predominant massive and pillowed mafic flows with minor pillow breccia and hyaloclastite. The colour of the mafic metavolcanics is highly varied and correlates in a general way with the intensity of secondary alteration. The freshest rocks have a dark green colour with a black weathered surface whereas the most altered rocks have a light, waxy green fresh surface and a weathered surface that is very light in colour and approaches white in the most severely altered rocks. Both fine- and medium-grained varieties are present and the medium-grained rocks are thought to be thick flows rather than sills because intrusive relationships have not been identified and, rarely, medium-grained rocks are observed to grade upwards into massive and pillowed mafic flows. Most rocks are equigranular and, when present, plagioclase phenocrysts are generally less than 1 mm in longest dimension.

Where pillows are not highly deformed, they typically are small and have length to width ratios of 1:1 to 2:1. The selvage edges of the pillows are generally thin (<1 cm) and the interpillow spaces are filled with hyaloclastite or, more rarely, chert, quartz, or carbonate. Locally, as at the outcrop approximately 200 m south-

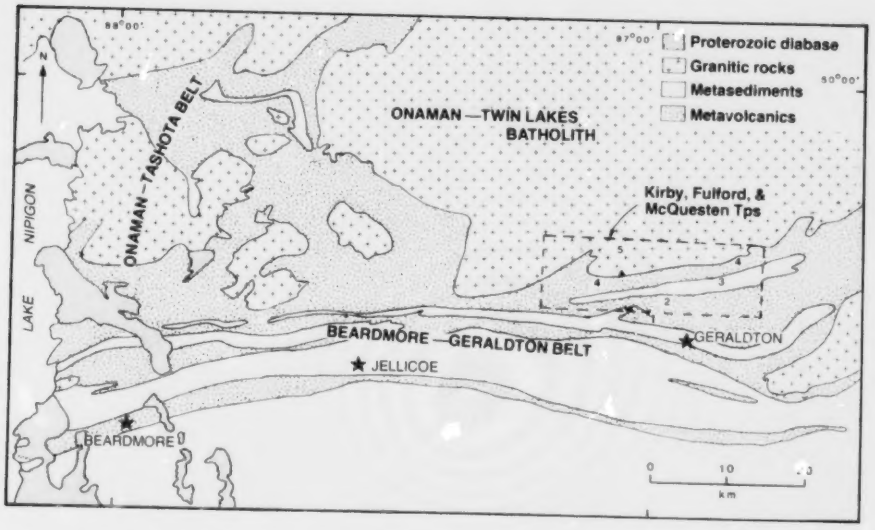

Figure 2. *General geology of the Beardmore-Geraldton area. The numbers in Kirby, Fulford, and McQuesten Townships refer to the Volcan Lake metasediments (1), the Dionne Lake metavolcanics (2), the Hutchison Lake metasediments (3), the Kirby Lake metavolcanics (4), and the Onaman-Twin Lakes batholith (5).*

southeast of the shaft on the Gulch Resources Limited (15) property, the pillows display a concentric zonation. Here, the interiors of the larger pillows have a feldspar-phyric core that grades outwards through an aphyric, equigranular zone and a vesicular, equigranular zone to a chilled rind and interpillow hyaloclastite. The vesicles are radially disposed within the pillows. Vesicles generally make up less than 5 percent, by volume, of the rock and are filled with quartz, carbonate, or chlorite. Broken pillow breccia and massive hyaloclastite are not abundant but are recognized locally as a minor facies of pillowed units. A relatively thick pillow breccia unit (>3 m) is present within a massive and pillowed flow sequence near the point where a small creek crosses the Trans-Canada natural gas pipeline in central McQuesten Township. Flow contacts tend to be more highly sheared and it is possible that some of these fragmental mafic metavolcanics are mistaken for intensely sheared massive and pillowed mafic flows.

In many rocks, the development of secondary mineralogy, alteration, and a penetrative deformational fabric has largely obliterated microscopic scale primary textures. Some aspects of the primary texture are preserved where primary minerals are partially preserved or replacement is pseudomorphic. The texture of the equigranular varieties varies from subophitic in the medium-grained varieties to diabasic and, rarely, trachytic in the fine-grained varieties. Two types of plagioclase phenocrysts occur in the porphyritic variety.

Larger (0.5 to 1 mm), equant, rounded plagioclase phenocrysts seldom exceed 5 percent by volume of the rock (Photo 1). Smaller (<0.2 mm), subhedral, lath shaped plagioclase phenocrysts with length to width ratios ranging from 3:1 to 10:1, rarely constitute up to 30 percent of the rock. The two types of phenocrysts occur both separately and together.

In general, the Dionne Lake mafic metavolcanics are composed principally of a relatively sodic plagioclase and colourless to green actinolitic amphibole. The plagioclase is commonly almost completely altered to very fine grained, granular epidote with the result that plagioclase grains generally appear very nearly opaque in thin section. Incipient chloritic alteration of actinolite is most apparent in the finer grained varieties. Minor and accessory constituents include sphene, opaque min-

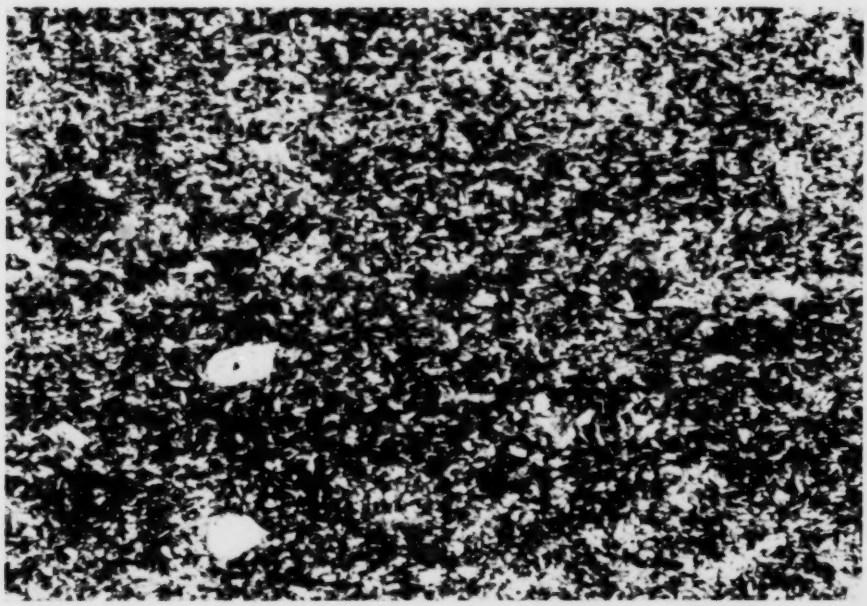

Photo 1. *Photomicrograph of a mafic flow with abundant plagioclase microlites and a larger plagioclase phenocryst. Field of view is 12 mm wide. Field sample number 199 from 1 km north of the island in the west end of Dionne Lake.*

erals, carbonate, quartz, and biotite. These mineral assemblages are indicative of partially retrograded upper greenschist to lower amphibolite facies regional metamorphism.

Alteration and Veining within the Dionne Lake Mafic Metavolcanics

In addition to the secondary mineral development discussed above, many of these rocks have experienced significant further alteration. This alteration is most conspicuously developed on the Gulch Resources Limited (15) property where most of the rocks have been affected. Certain outcrops or parts of outcrops to the north of Dionne Lake and south of the airport have been selectively altered.

The most obvious megascopic characteristic that distinguishes unaltered from altered mafic flows is the latter's light, waxy green colour on the fresh surface that imparts a felsic appearance. The weathered surface also has a lighter colour (grey to buff) in the more altered rocks. Alteration is generally more commonly observed and more intensely developed in the finer grained flows. This may be due to the medium-grained massive interiors of flows lacking the necessary permeability due to concentration of penetrative deformational fabrics in the finer grained varieties. Alternatively, the finer grained flows may have originally been glassy and more susceptible to hydration reactions than crystalline flows. Where the alteration is not pervasive, it is spatially associated with quartz and/or carbonate veins suggesting a causal relationship between alteration and the introduction of volatiles and fluids.

The alteration is manifest as intense retrograde alteration of upper greenschist–lower amphibolite facies mineral assemblages and introduction of secondary minerals. The most conspicuous retrograde reaction is that of actinolite altering to chlorite. Actinolite is relatively well preserved with only minor retrograde alteration to chlorite in relatively unaltered rock. In the most altered rocks actinolite is completely altered to chlorite and partial alteration is apparent in intermediate stages (Photo 2). Epidotization of feldspar is also more conspicuous in the altered

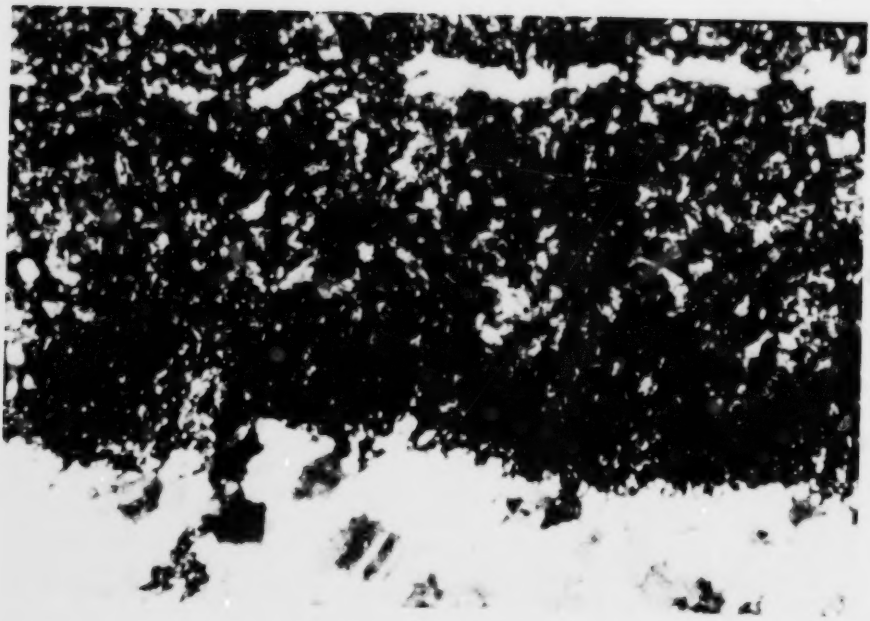

Photo 2. *Alteration of a mafic metavolcanic adjacent to a carbonate-quartz vein. The vein is zoned with a coarsely crystalline carbonate interior and a narrow, fine-grained quartz margin. Adjacent to the larger vein, actinolite (light coloured) in the mafic metavolcanic is replaced by fine-grained, shreddy chlorite. Width of the field of view is approximately 3 mm. 1 km southwest of Hutal Lake.*

rocks. Abundant secondary quartz and carbonate occur as veins, discontinuous patches, and intergranular grains. The time of introduction of secondary quartz and carbonate overlaps but crosscutting relationships between veins and within diffusely altered zones suggests that the carbonate tends to be later. Alteration is most intense adjacent to veins (Photo 2) but also occurs along fractures with no quartz and/or carbonate filling and as diffuse patches unrelated to obvious fractures. Some of the changes associated with the alterations are illustrated in Photo 2. The central part of the vein is filled with carbonate with minor quartz and a narrow quartz-rich border phase is developed intermittently along the margins of the vein. It is not clear in this example if the quartz preceded the carbonate or if this represents zoning associated with a single episode of veining. A 0.5 to 1.0 mm wide alteration zone occurs on either side of the vein and is distinguished from the less altered rock by the finer grain size, complete replacement of actinolite by chlorite, and the abundance of very fine, intergranular quartz and carbonate. Partially replaced actinolite crystals near the edge of the alteration zone illustrates an intermediate stage of the alteration.

Some of the reactions associated with this alteration are similar to, but more intense than, the regional retrograde alteration. The association with abundant secondary quartz and carbonate suggests that the intensity of the alteration may be related to the presence of volatiles that could enhance recrystallization and promote hydration reactions.

Kirby Lake Mafic Metavolcanics

The Kirby Lake mafic metavolcanics include massive and pillowed mafic flows. In comparison with those of the Dionne Lake metavolcanic unit, these are more intensely deformed and have mineral assemblages indicative of more intense

metamorphic conditions. The rocks are dark green to black on fresh surface and generally weather black. Grain size ranges from fine grained to medium grained but these rocks are generally coarser grained than those of the Dionne Lake metavolcanic unit. The coarser grain size is probably a consequence of recrystallization rather than any primary difference. Some of the medium-grained rocks represent the interior of thick flows but the distinction between medium-grained basalt and metamorphosed mafic sills (unit 5 on map in back pocket) is difficult to make without abundant, good quality outcrop. On the accompanying map (back pocket), medium-grained mafic rocks are designated as medium-grained mafic flows where no evidence to the contrary was identified in the field.

Most primary structures have been obliterated by intense deformation and recrystallization. Pillowed units are comparatively easily distinguished on the basis of their irregular weathered surface that contrasts with the smoother weathered surface of the massive units. Pillows are commonly highly deformed with length to width ratios in excess of 10:1 being common.

Most of the rocks presently have equigranular, granoblastic texture but phenocrysts of the type observed in the Dionne Lake mafic metavolcanics would probably not be recognizable with this degree of recrystallization. One distinctive porphyritic variety occurs south of McQuesten Lake at the contact with the Onaman-Twin Lakes batholith. Here, rounded plagioclase phenocrysts up to 2 cm in longest dimension occur within a matrix otherwise typical of the amphibolitic basalts of this area.

The only primary structures that can be clearly identified are pillows. In general, the pillows are highly deformed with length to width ratios commonly in excess of 10:1. Mafic metavolcanics other than pillowed and massive flows (e.g. pillow breccia, hyaloclastite) may be present but obscured by the deformation and recrystallization. In one outcrop approximately 2 km east of McQuesten Lake, the pillows are relatively less deformed with length to width ratios of 1:1 to 2:1. The packing of pillows in this outcrop suggests tops to the south but, in general, the state of deformation precludes such determinations.

These rocks are composed principally of plagioclase and hornblende. In thin section, the rocks are optically clear in contrast to the cloudy nature of those from the Dionne Lake metavolcanic unit. Fibrous actinolite occurs along with hornblende in some of the rocks. Minor amounts of opaque minerals and quartz are common. Secondary quartz and carbonate occur in these rocks but are not nearly as abundant as in the Dionne Lake mafic metavolcanics.

Amphibolitic inclusions are especially common in a northeastward trending zone within the Onaman-Twin Lakes batholith that extends off the end of the volcanic promontory north of Kirby Lake (Figure 3). Primary volcanic structures are not observed in these inclusions but they are inferred to represent mafic volcanic rocks on the basis of this relationship to the volcanic promontory. The mineralogy and texture of these inclusions are analogous to those observed in the Kirby Lake mafic metavolcanics near the contact with the batholith. This zone represents a fragmentary continuation of the Kirby Lake metavolcanic unit.

Felsic Metavolcanics

The main occurrence of felsic metavolcanics in the map area is in the eastern part of the Dionne Lake metavolcanics in southern McQuesten Township and southeastern Fulford Township. The extent of the felsic metavolcanics in this area is poorly understood due to the paucity of bedrock outcrop. Felsic metavolcanics are a minor component in the Kirby Lake metavolcanics where they are restricted to the central part of the unit in western McQuesten Township.

The felsic metavolcanics consist principally of tuff and subordinate lapilli-tuff and tuff-breccia (fragment size classification after R.V. Fisher 1966). Flows have not been recognized and porphyry dikes are volumetrically minor. Most of the felsic metavolcanics are grey to waxy green on the fresh surface and have buff coloured weathered surfaces. The exception to this occurs where carbonate alteration is extensive and imparts a rusty brown colour to the rock. Fragments tend to

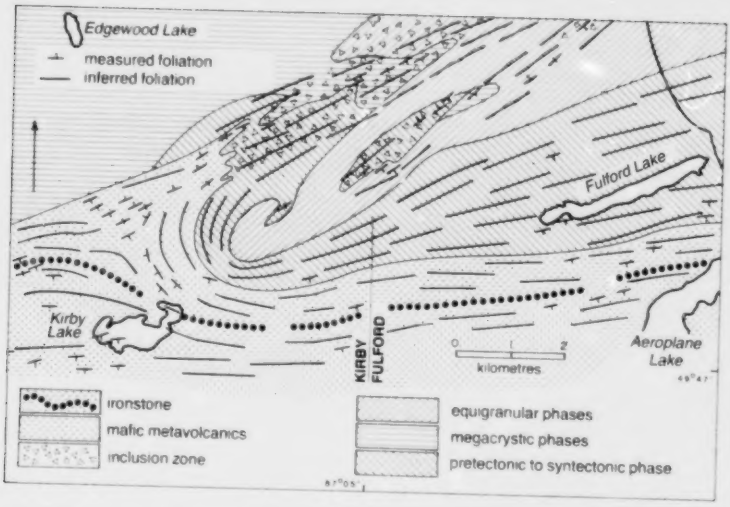

Figure 3. *Geological map of the Kirby Lake structure illustrating the trend of foliation and the distribution of the amphibolite inclusion-rich zone in the granitoid rocks.*

be more resistant than the matrix and stand out in relief on the weathered surfaces.

The tuffs typically are massive or have a poorly defined layering. No primary structures indicative of reworking in the sedimentary environment are present although many may have been deposited in an aqueous environment. These rocks consist of crystals, crystal fragments, and lithic fragments up to 2 mm in diameter set in a finer grained sericitic matrix. Plagioclase is by far the most abundant mineral represented among the crystals, and crystal fragments. In the least deformed rocks the plagioclase is angular and rarely preserves its subhedral shape. Rounded quartz is less common and generally recrystallized into a polycrystalline aggregate. The rounding is thought to be due, in large part, to incorporation of resorbed quartz phenocrysts rather than abrasion associated with transport and deposition. Ash-size lithic fragments commonly consist of very fine grained, sericitic, equigranular to porphyritic (plagioclase) felsic volcanic rocks. The matrix is very fine grained and consists mainly of quartz, feldspar and sericite. In several samples the grain size distribution appears to be bimodal with 0.5 to 2.0 mm crystal and lithic fragments and finer grained matrix (<0.05 mm). In addition to occurring as the fine-grained, shreddy variety of sericite, muscovite rarely occurs as larger (<0.5 mm), poikilitic plates that can be oriented either parallel or at high angles to the foliation. Biotite constitutes up to approximately 5 percent of the rock in some samples, especially those from the Kirby Lake metavolcanics. Epidote and actinolite are rare. Disseminated sulphide minerals (pyrite and pyrrhotite) and secondary carbonate and quartz are common.

The mineralogy of the tuff-breccia and lapilli-tuff is similar to that of the tuff. The lithic fragments tend to be compositionally uniform but texturally diverse in a single unit (Photo 3). This aspect was investigated for a single outcrop of tuff-breccia along Highway 584 west of Marie Lake by slabbing several samples and selecting thin sections of specific fragments. Most of the fragments are relatively unaffected by the pervasive carbonatization that has almost completely replaced the matrix. The fragments are interpreted to be in the compositional range of dacite to rhyodacite based on their quartzofeldspathic nature and rare presence of quartz phenocrysts. The fragments appear to be heterolithic because there is a considerable variety in textures and secondary mineralogy attendant upon variation in the percentage of phenocrysts, intensity of sericitic alteration, intensity of carbonatiza-

Photo 3. *Felsic tuff-breccia with fragments which exhibit a wide variety in textures but have uniform dacitic to rhyodacitic compositions. The matrix is intensely carbonatized. Highway 584, west of Marie Lake.*

tion, and vesicularity. The presence of feathery terminations suggests that some of the fragments are flattened scoria and pumice (fiamme). Some broken phenocrysts are present in the matrix. Although some tectonic rounding has occurred, the fragments are relatively angular. These properties are similar to those proposed by E. Dimroth (1977) for a magmatic explosion fragmentation mechanism

Up to 5 percent stringer and disseminated sulphide minerals (pyrite and pyrrhotite) are present locally in this same outcrop. The sulphide mineralization apparently both predates and postdates brecciation since the sulphide mineralization occurs both as stringers within fragments that abruptly terminate at the edge of the fragments and as stringers and disseminations within the matrix and along fragment boundaries.

Feldspar and, more rarely, feldspar-quartz porphyries are a volumetrically minor rock type. Their occurrence has been noted at two localities, north of Dionne Lake in the Dionne Lake metavolcanics. The plagioclase phenocrysts are generally equant, subhedral to euhedral crystals with minor tectonic rounding. They are less than 2 mm in diameter and are estimated to compose up to 30 percent of the rock. Rare quartz phenocrysts are rounded, lenticular crystals, some of which show embayments indicative of resorption by the melt. The matrix is very fine grained (<0.04 mm) and consists largely of feldspar and quartz in indeterminate propor-

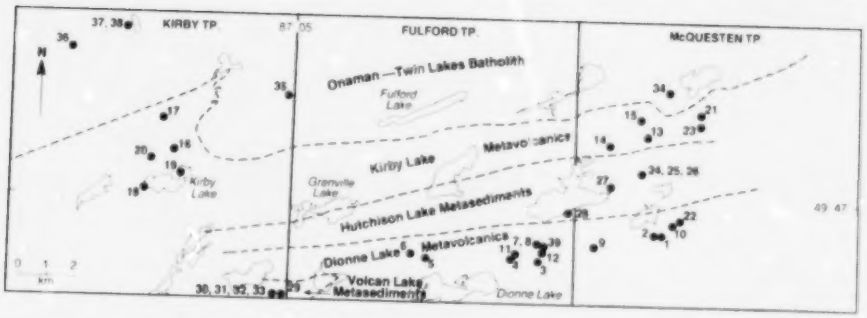

Figure 4. *Map illustrating the location of chemically analyzed samples in the Grenville Lake area. See Tables 2, 6, 10, and 12.*

tions with sericite and minor amounts of chlorite, epidote, and opaque minerals. Secondary quartz and carbonate is present but not as abundant as in the fragmental varieties. The nature of these rocks, whether hypabyssal intrusive or flows, is not clear. Aphyric felsite dikes occur in mafic metavolcanics near a small felsic unit approximately 1.5 km south of the island in McQuesten Lake.

Petrochemistry of the Metavolcanics

Chemical analyses (Geoscience Laboratories, Ontario Geological Survey, Toronto) of major and selected trace elements were carried out on 23 samples of metavolcanic and related rocks from the Grenville Lake area. The locations of analyzed samples are illustrated in Figure 4 and the data are tabulated in Table 2 and plotted in Figures 5 to 9. The samples include 17 basalts, four gabbros, one intermediate to felsic tuff, and one rhyolite dike.

Most of the mafic metavolcanics and gabbros can be classified as subalkaline, tholeiitic basalt. Noteworthy exceptions to this generalization are samples 5 and 11. Sample 11 is a gabbro that differs significantly from the other mafic rocks in its higher (2.42 percent *vs.* 0.0 to 0.28 percent) K_2O content. The amphibole in this sample is partially replaced by biotite and it is probable that this sample has been affected by potassium metasomatism. The introduction of secondary potassium could explain the classification of this rock as alkalic (Figure 5) and calc-alkaline (Figure 7) on diagrams utilizing alkalies. In a plot not employing alkalies as one of the determinants, this sample is tholeiitic (Figure 8). The other anomalous sample (5) is the only plagioclase-phyric sample (see Photo 2) analyzed and may not represent a true liquid composition. Further, the plagioclase in this sample has a higher normative albite component and it is not clear if this is a primary or secondary (due to metamorphism) feature. In view of these possible complications, little significance is attached to the more calc-alkalic character of this sample.

The gabbros (samples 10, 11, 12, and 21) do not differ substantially from the remainder of the mafic rocks with the exception noted above for sample 11 and the slightly higher Mg/Fe ratio of samples 11 and 12 (Figures 7 and 8). The latter suggests that some of the gabbro may represent cumulates resulting from shallow-level fractionation concentrating earlier formed ferromagnesian minerals.

Although the mafic rocks from the Kirby Lake and Dionne Lake metavolcanics tend to cluster together (Figures 5 to 8), examination of histograms (Figure 9) reveals differences between these two series. Relative to the Kirby Lake metavolcanics, mafic rocks in the Dionne Lake metavolcanics tend to have lower total Fe, CaO, Co, Cu, and Ni and higher CO_2, H_2O, As, and Au. Also noteworthy is the greater dispersion of results for the Dionne Lake metavolcanics. Some of these observations can be explained by the overall lower metamorphic grade of the Dionne Lake metavolcanics as well as the wide range in intensity of secondary

TABLE 2. CHEMICAL ANALYSES OF METAVOLCANICS IN THE GRENVILLE LAKE AREA. Analyses 1 to 12 and 22 are from the Dionne Lake metavolcanics and include basalt (1 to 9), gabbro (10 to 12), and intermediate to felsic metavolcanics (22). Analyses 13 to 21 and 23 are from the Kirby Lake metavolcanics and include basalt (13 to 20), gabbro (21), and felsic metavolcanics (23). Sample locations are illustrated in Figure 4. Major elements are reported as weight percent of the oxide and trace elements as ppm except where noted ppb.

Analysis Number	1	2	3	4	5	6	7	8	9	10	11	12
Field Number	72	73	89	133	199	206	209A	209B	216	66	131	213A
SiO_2	46.00	49.20	49.30	52.90	53.90	50.30	49.70	49.20	46.80	46.90	46.90	47.60
TiO_2	1.15	0.85	0.75	0.87	0.98	0.86	0.94	1.11	0.86	1.28	1.07	0.65
Al_2O_3	14.70	14.50	15.40	15.10	16.10	15.00	14.20	14.00	12.80	14.10	12.80	15.60
Fe_2O_3	3.73	2.85	2.25	2.90	2.69	4.46	3.03	3.86	1.93	3.55	3.26	2.71
FeO	7.16	8.18	6.28	5.77	6.21	6.94	6.43	8.91	8.33	9.86	6.06	5.84
MnO	0.22	0.19	0.19	0.15	0.21	0.18	0.18	0.19	0.18	0.15	0.13	0.14
MgO	3.83	8.19	7.11	7.09	4.14	6.46	7.04	7.89	7.95	7.51	9.38	10.30
CaO	13.90	9.60	12.10	9.93	5.15	10.90	11.10	8.06	9.52	9.16	9.12	10.30
Na_2O	1.08	1.20	1.11	1.36	4.20	1.42	1.45	2.54	1.14	1.23	2.09	1.18
K_2O	0.0	0.01	0.02	0.16	0.22	0.16	0.0	0.12	0.0	0.16	2.42	0.28
P_2O_5	0.10	0.06	0.07	0.09	0.25	0.07	0.07	0.06	0.06	0.07	0.12	0.09
CO_2	3.64	0.37	1.74	0.93	1.62	0.20	1.87	0.10	5.77	1.02	3.23	0.52
S	0.01	0.02	0.02	0.02	0.01	0.04	0.02	0.02	0.02	0.02	0.13	0.02
H_2O^+	2.55	3.38	3.00	2.86	2.93	2.57	3.02	3.12	4.86	4.05	2.49	3.49
H_2O^-	0.03	0.04	0.03	0.06	0.04	0.03	0.03	0.05	0.04	0.05	0.04	0.06
Total	98.10	98.64	99.33	99.18	98.65	99.59	99.08	99.23	100.26	99.11	99.24	98.78

TABLE 2 cont'd.

Analysis Number	1	2	3	4	5	6	7	8	9	10	11	12
Field Number	**72**	**73**	**89**	**133**	**199**	**206**	**209A**	**209B**	**216**	**66**	**131**	**213A**
Rb	<10	<10	<10	<10	10	<10	<10	<10	<10	<10	80	<10
Sr	125	95	80	75	425	180	80	75	45	95	385	130
Li	6	12	12	13	19	10	11	10	17	14	26	16
Ba	40	30	50	80	70	71	30	60	20	50	790	60
Ce	<35	<35	<35	35	130	40	35	45	45	<35	80	35
Nd	<30	<30	<30	35	70	35	30	40	40	<30	60	35
Y	18	12	13	14	20	16	13	17	13	21	15	7
Co	45	38	34	36	19	41	34	44	36	47	37	40
Cr	234	277	420	377	88	55	271	91	243	220	505	342
Cu	104	94	84	106	36	56	74	118	74	106	64	15
Ni	100	55	50	59	29	52	53	36	42	86	129	143
Pb	<10	<10	<10	<10	<10	<10	<10	<10	<10	134	<10	<10
V	315	280	235	255	120	255	270	320	260	315	185	180
Zn	86	96	76	80	138	93	78	101	79	82	84	52
Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
As	70	160	90	20	10	170	60	120	150	70	40	170
Au(ppb)	<2	8	10	3	<2	3	7	4	<2	4	<2	6

TABLE 2 cont'd.

Analysis Number	13	14	15	16	17	18	19	20	21	22	23
Field Number	**35**	**52A**	**96A**	**112**	**115**	**241**	**243**	**1058**	**39**	**63**	**158**
Rb	<10	<10	<10	<10	<10	<10	<10	<10	<10	20	30
Sr	100	105	120	85	90	65	190	90	85	185	315
Li	12	8	5	7	14	9	7	8	15	16	10
Ba	90	90	50	50	40	40	50	60	80	100	510
Ce	<35	<35	35	40	40	40	45	60	40	<35	<35
Nd	<30	<30	<30	35	<30	35	40	50	35	<30	<30
Y	16	16	18	19	18	15	11	16	11	15	<2
Co	51	51	41	43	46	49	43	45	46	31	6
Cr	210	209	306	182	270	169	300	318	290	216	7
Cu	164	155	118	130	159	102	114	64	70	50	5
Ni	100	114	117	85	107	89	101	131	180	87	<5
Pb	345	530	<10	<10	<10	<10	<10	<10	15	<10	<10
V	290	285	295	315	285	290	26 5	275	260	150	11
Zn	106	106	96	106	97	86	92	89	78	88	24
Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
As	50	60	<10	20	<10	<10	<10	<10	20	10	20
Au(ppb)	<2	<2	<2	4	3	<2	<2	<2	<2	<2	<2

TABLE 2 cont'd.

Analysis Number	13	14	15	16	17	18	19	20	21	22	23
Field Number	**35**	**52A**	**96A**	**112**	**115**	**241**	**243**	**1056**	**39**	**63**	**158**
SiO_2	46.00	47.30	49.00	49.00	48.80	48.10	49.20	48.90	47.20	55.30	69.00
TiO_2	0.95	0.93	0.99	0.91	0.84	0.81	0.77	0.96	0.85	0.90	0.13
Al_2O_3	14.60	14.90	14.90	13.80	14.20	15.00	14.20	15.00	15.20	14.10	17.70
Fe_2O_3	2.65	1.57	2.03	2.58	2.95	2.88	2.86	2.94	2.61	2.18	0.21
FeO	10.70	10.80	9.57	10.20	10.20	8.25	9.49	9.06	9.20	6.86	0.83
MnO	0.22	0.18	0.19	0.22	0.18	0.24	0.20	0.19	0.18	0.14	0.01
MgO	5.32	7.34	7.54	7.73	7.82	7.36	7.92	7.47	9.83	5.43	0.80
CaO	12.50	11.50	11.60	11.40	12.20	12.10	11.90	10.50	10.00	6.97	3.18
Na_2O	1.70	1.78	1.55	1.9	0.70	1.46	1.40	1.81	1.48	1.96	5.32
K_2O	0.21	0.13	0.18	0.15	0.10	0.08	0.06	0.09	0.26	0.45	1.36
P_2O_5	0.07	0.07	0.09	0.09	0.08	0.06	0.07	0.08	0.08	0.11	0.07
CO_2	2.58	0.82	0.35	0.07	0.07	0.86	0.06	0.15	0.26	1.93	0.53
S	0.02	0.02	0.02	0.03	0.10	0.02	0.05	0.03	0.07	0.02	0.01
H_2O^+	1.24	1.10	1.29	1.03	1.12	0.88	0.96	1.54	2.07	2.98	0.71
H_2O^-	0.05	0.04	0.04	0.03	0.04	0.04	0.03	0.04	0.04	0.04	0.03
Total	98.81	98.48	88.34	98.53	99.40	98.14	99.17	98.76	99.33	99.27	99.79

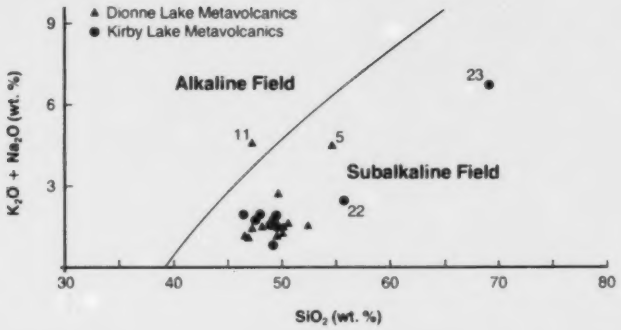

Figure 5. *Total alkalies vs. SiO_2 for metavolcanics from the Grenville Lake area. Subdivision into alkaline and subalkaline fields is after T.N. Irvine and W.R.A. Baragar (1971).*

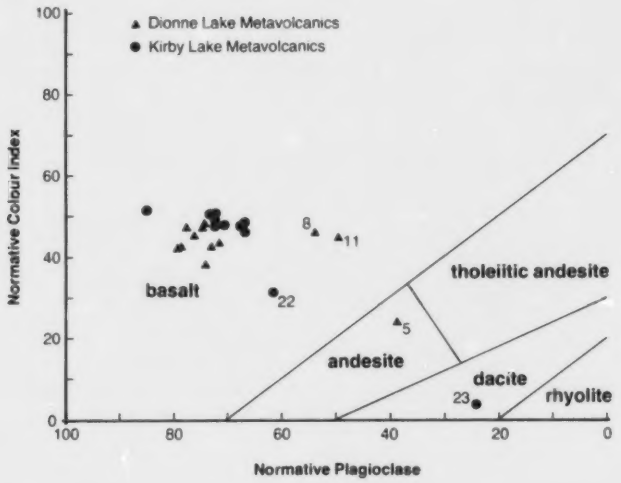

Figure 6. *Normative colour index vs. normative plagioclase for metavolcanics from the Grenville Lake area. Fields are after T.N. Irvine and W.R.A. Baragar (1971).*

alteration exhibited by these rocks. Devolatilization reactions accompanying amphibolite facies metamorphism can explain the lower H_2O and perhaps CO_2 in the Kirby Lake metavolcanics although it is also probable that secondary alteration may have enriched these elements (as well as As and Au?) in the Dionne Lake metavolcanics. The difference in total Fe is not readily explainable and it is possible that the primary chemical characteristics of mafic magma in the two metavolcanic series may differ. Further analyses of relatively immobile elements may be able to clarify this possibility.

METASEDIMENTS

Clastic Metasediments

Clastic metasediments occur in two geographically distinct belts. The northern belt, referred to here as the Hutchison Lake metasediments, occurs in central McQuesten Township and east-central Fulford Township and is extended through Fulford Township to Wildgoose Lake in southeast Kirby Township on the basis of aeromagnetic trends (Ontario Division of Mines-Geological Survey of Canada

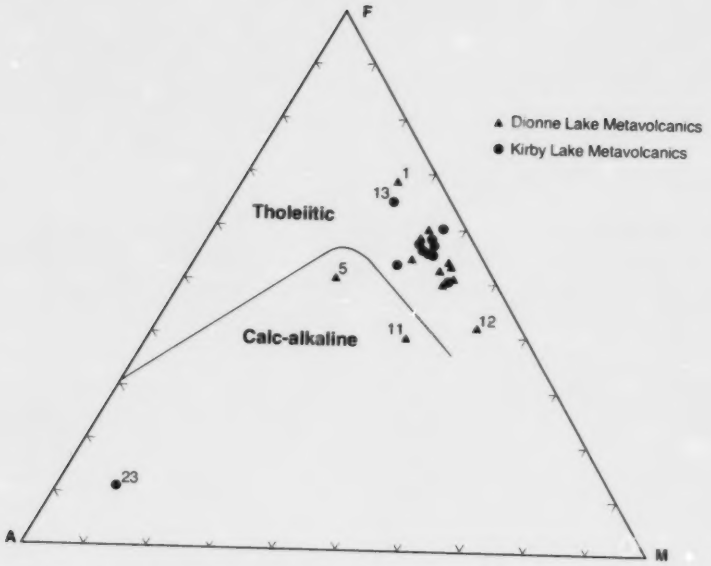

Figure 7. AFM ternary plot for metavolcanics from the Grenville Lake area. Subdivision into calc-alkaline and tholeiitic fields is after T.N. Irvine and W.R.A. Baragar (1971). A=weight percent Na_2O + K_2O; F=weight percent FeO + 0.8998 Fe_2O_3; M=weight percent MgO.

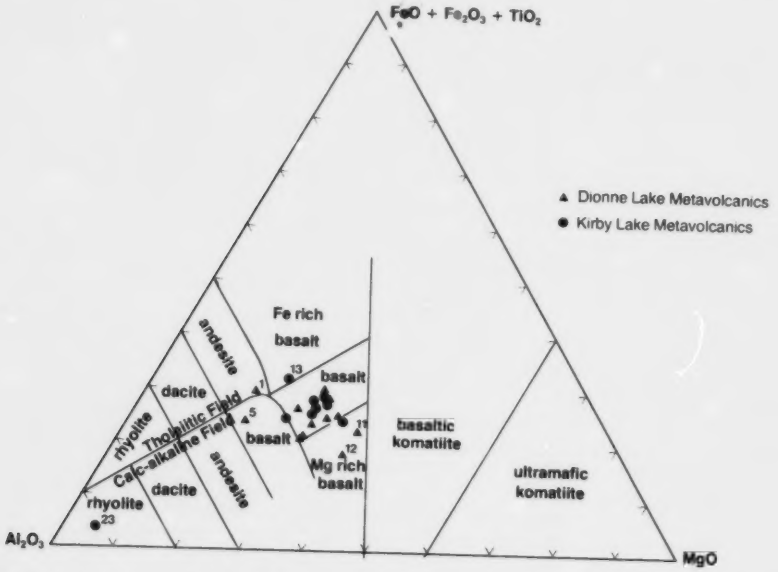

Figure 8. Al_2O_3-FeO+Fe_2O_3+TiO_2-MgO ternary plot for metavolcanics from the Grenville Lake area. Calculation of ternary components and fields are after L.S. Jensen (1976) and E.C. Grunsky (1981).

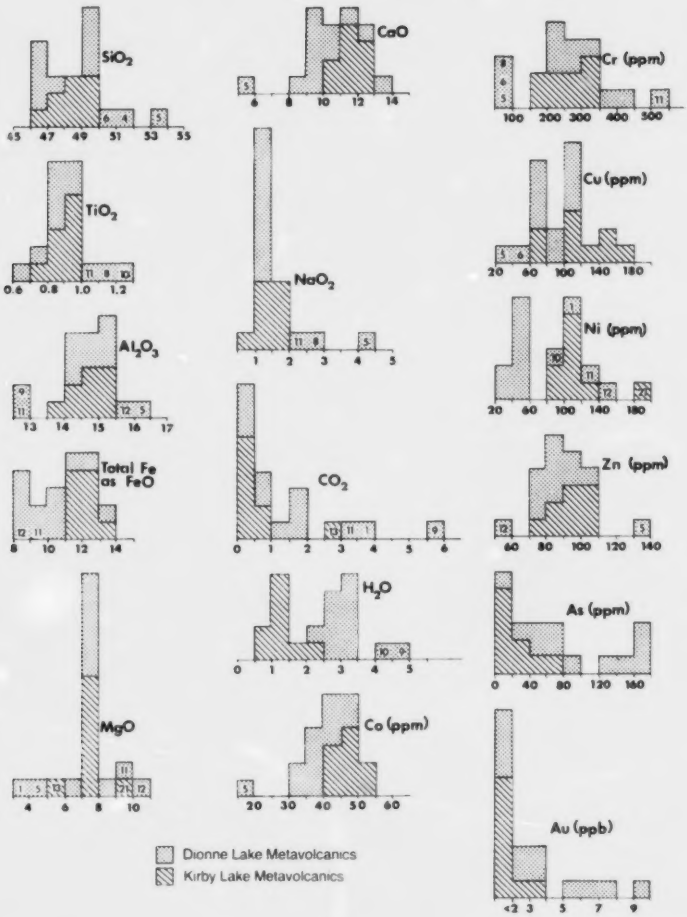

Figure 9. *Histograms illustrating the abundances of selected oxides and elements in metavolcanics from the Grenville Lake area. Outliers discussed in the text are identified by the analysis number from Table 2.*

1974a,b,c,d) and a single outcrop on North Bay (Wildgoose Lake). The possible extension of this unit to the west could not be determined because of extensive Pleistocene deposits. To the east, the Hutchison Lake belt extends for several kilometres beyond the east boundary of McQuesten Township (Macdonald 1943).

A second unit of clastic metasediments, referred to as the Volcan Lake metasediments, is present in southeast Kirby Township and southwest Fulford Township. The margins of this unit cannot be precisely located because of extensive Pleistocene deposits. The Volcan Lake metasediments may represent an eastward continuation of a laterally extensive unit of similarly conglomeratic metasediments that extends from Lake Nipigon through Dorothea, Sandra, and Irwin Townships (Mackasey 1975), Walters and Leduc Townships (Mackasey 1976), Legault and Colter Townships (Mackasey *et al.* 1976a,b) and possibly, beneath extensive Pleistocene cover, through northern Lindsley and southern Kirby Townships. These two belts are discussed separately below followed by a comparative analysis.

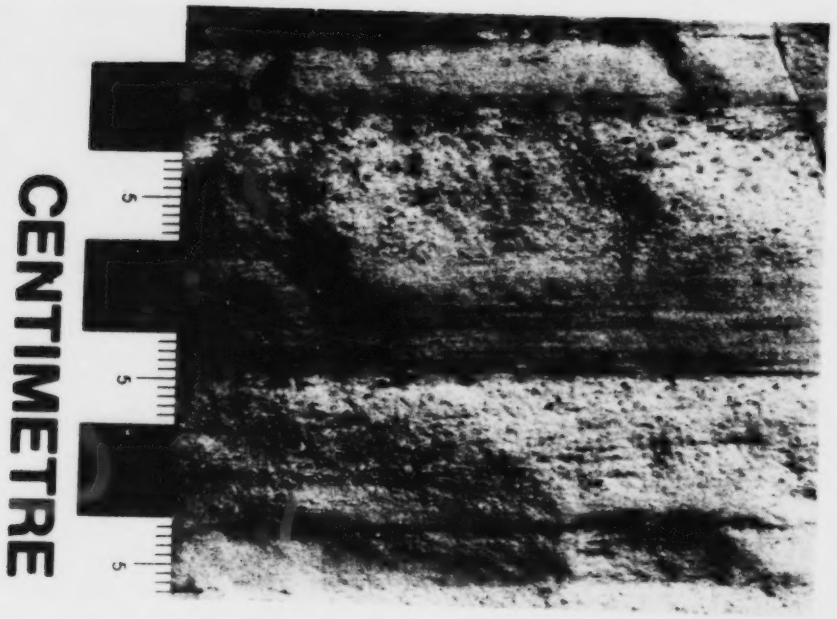

Photo 4. *Thin, graded beds in wacke near bend in Burrows River, 1 km north of Hutal Lake.*

Hutchison Lake Metasediments (Wacke-Turbidite Association)

The predominant rock types in the Hutchison Lake metasediments are metamorphosed feldspathic wacke with associated siltstone. Lesser amounts of magnetite and chloritic schist are interlayered with the wacke in the eastern part of the map area.

Wacke

The grey to buff weathering wackes of the Hutchison Lake metasediments display limited variation in their compositional and sedimentological characteristics. These rocks are commonly very thinly to medium bedded (1 to 30 cm); thicker beds are extremely rare. The thickness of individual beds tends to be uniform along strike; 1 cm thick beds can be traced for tens of metres across outcrop with no change in thickness. Where changes in thickness are observed, they are due to scour by currents depositing overlying beds rather than original depositional thinning.

Graded bedding is commonly present with a medium to very coarse sand base grading upward into a fine sand to silt top (Photo 4). The upper part of individual layers may display thin parallel laminations. The extreme tops of a small percentage of layers are characterized by a magnetite-rich zone (discussed below). The lower contacts of the beds are sharp and generally parallel to the laminations in the upper part of the underlying bed but scour structures are common (Photo 5). In one outcrop, a series of broad, shallow scours appears to be "nested" with successive beds being similarly scoured. Detailed examples of bedding characteristics in one well exposed, typical outcrop is presented in Figure 10.

The aforementioned bedding characteristics are indicative of deposition from turbidity currents, below wave base. In terms of the Bouma model (Walker 1979), most beds can be described as AB turbidites although A, AE, and ABE turbidites are also present. The Bouma C division is conspicuously lacking. Lack of outcrop and structural discontinuities preclude tracing this unit laterally to its source. The proximity to the source is unknown but the presence of "nested" scours suggests that successive turbidites were repeatedly channeled across the same part of the

Photo 5. *Scour structure in wacke. The overlying graded bed truncates fine laminations in the upper, fine-grained part of the underlying graded bed. Near bend in Burrows River, 1 km north of Hutal Lake.*

depositional fan because of either topographic irregularities on the depositional surface, or proximity to source.

These rocks have been sheared and extensively recrystallized making it difficult to distinguish matrix from recrystallized, sand-size lithic fragments. Sand-size grains that can be clearly identified as such include, in order of decreasing relative abundance, plagioclase, quartz, felsic volcanic lithic fragments, and, rarely, felsic plutonic lithic fragments. Such grains typically compose 20 to 30 percent of the area of a thin section.The different types of grains display a consistent, hierarchal susceptibility to recrystallization, alteration, and deformation (Photo 6). Quartz has undulatory to patchy extinction, and although many grains have a lenticular shape some preserve an angular presumably primary shape. Plagioclase exhibits moderate to intense sericitization and more intense flattening than quartz. It is possible that a minor amount of highly sheared and altered plagioclase could be present in the "matrix". Felsic volcanic lithic fragments are usually cryptic due to intense flattening and recrystallization that renders them difficult to distinguish from matrix.

Many sand-size plagioclase grains have albite twinning and the few with suitable optical orientation for compositional determinations are relatively sodic (albite-oligoclase). The plagioclase also exhibits weak to moderately intense sericitic alteration; secondary epidote or carbonate is rare in plagioclase, further attesting to the sodic composition. Zoning is present in a small proportion of plagioclase grains. K-feldspar is rare and occurs as patches in plagioclase rather than discrete grains.

The abundance of "matrix" observed in thin section reflects the true matrix as well as the extensively recrystallized lithic fragments no longer identifiable as such and the larger grains sectioned near their edges. This "matrix" consists of plagioclase, quartz, sericite, chlorite, epidote, opaque minerals, biotite, zircon, and apatite. The upper parts of graded beds are similar to this "matrix" but with different mineral proportions.

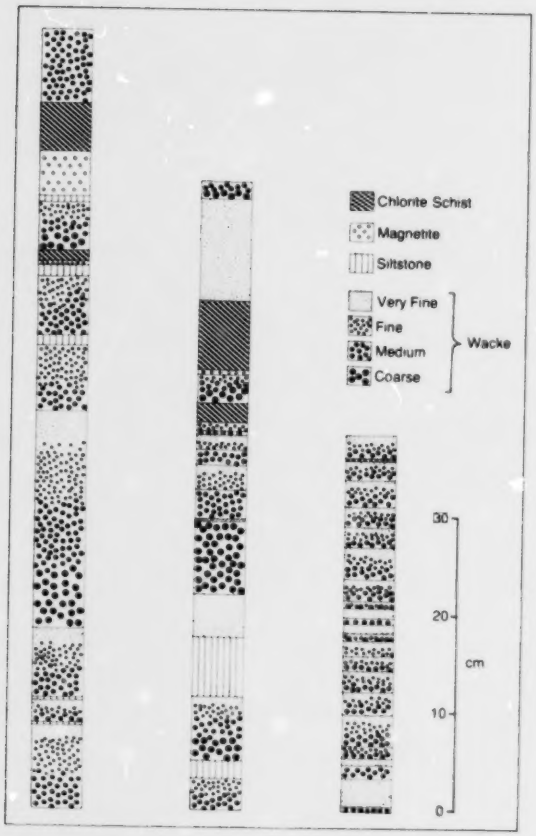

Figure 10. *Detailed sections measured in an outcrop of the Hutchison Lake metasediments illustrating the nature of the bedding. Horizontal lines separate individual beds. Graded bedding is illustrated diagrammatically by variation in grain size within individual beds.*

The difficulty of distinguishing matrix from recrystallized lithic fragments hampers application of more precise petrographic nomenclature (see Wood 1980, p.47) but these rocks are provisionally classified as lithic arkosic wacke. The reasons for this include the following.

1. Although the "matrix" includes recrystallized lithic fragments, careful examination of the least recrystallized rocks suggests that the true matrix is almost certainly greater than 15 percent. The very fine sand to silt tops of the beds further attest to the presence of a conspicuous fine component in the rocks as a whole.
2. Plagioclase is very much more abundant than quartz and if either component has been underestimated due to the effects of recrystallization, it is likely the plagioclase.
3. Lithic fragments are mainly cryptic but examination of the least recrystallized samples suggests that their abundance is approximately 50 to 100 percent of that of the feldspar.

The available evidence suggests that these rocks represent comparatively immature sediments that were deposited from turbidity currents in a lacustrine or marine basin. The proximity to the source of the sediment is not well established.

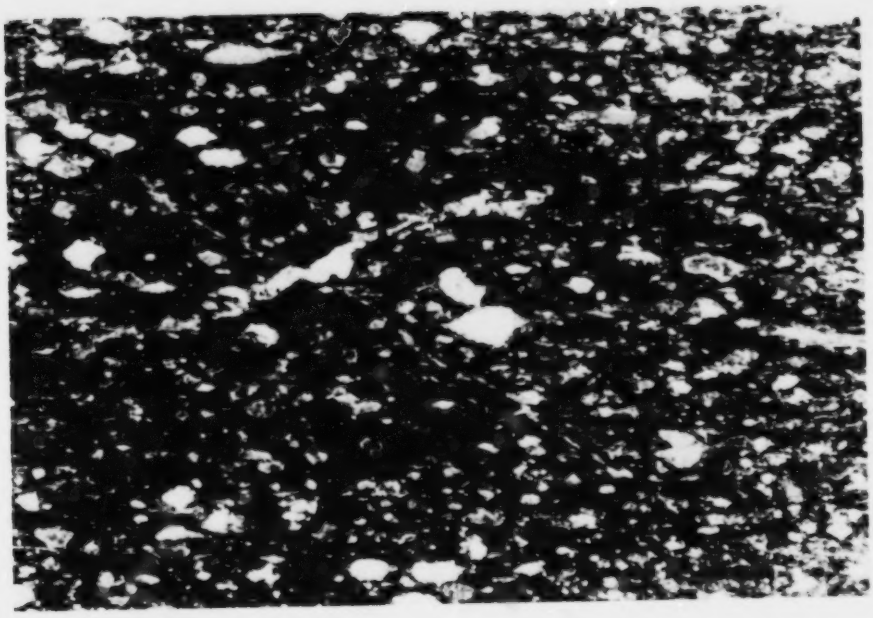

Photo 6. *Photomicrograph (plane polarized light) illustrating the texture of wacke. Most of the recognizable sand-size grains are plagioclase and quartz. Most lithic fragments are difficult to distinguish from recrystallized matrix. Width of field of view is approximately 12 mm. South shore of Hutchison Lake.*

Magnetite Layers

Magnetite-rich layers are conspicuously interlayered with wacke in the Hutchison Lake metasediments to the north and northeast of Hutal Lake. These magnetite layers are the source of a prominent aeromagnetic anomaly that lies within the Hutchison Lake metasediments extending from Hutchison Lake to the central part of Houck Township which adjoins McQuesten Township to the east (Ontario Division of Mines-Geological Survey of Canada 1974a,b,c,d).

The magnetite-rich layers range in thickness from 0.1 mm to 30 cm. In detail, the thicker layers are commonly composite with thin laminations of fine-grained wacke or siltstone. There is a strong tendency for magnetite-rich layers to be concentrated in distinct stratigraphic zones along with chloritic schists and concordant quartz veining (Photo 7). These zones are also characterized by minor faulting at a shallow angle to bedding and contorted bedding that does not occur in the parts of the sequence devoid of magnetite layers. This contrasting structural behaviour is interpreted to be a consequence of the extreme ductility contrasts in these heterolithic zones.

Some thin magnetite layers grade downward into the laminated (Bouma B) division of underlying turbidites. This suggests that the deposition of iron-rich sediments may have been a background sedimentation interrupted by the deposition from turbidity currents.

The magnetite layers are rarely monomineralic. Chlorite is commonly present and constitutes up to 50 percent of some magnetite-rich layers. The chlorite is interstitial to subhedral, equant magnetite crystals that rarely exhibit alteration to hematite. Minor quartz and feldspar (detrital ?) occur as small (<0.06 mm), equant grains. Biotite is common and occurs both as fine shreddy grains associated with chlorite and relatively large (<0.5 mm), tabular porphyroblasts that poikilitically enclose magnetite. Minor pyrite occurs as disseminated, euhedral crystals.

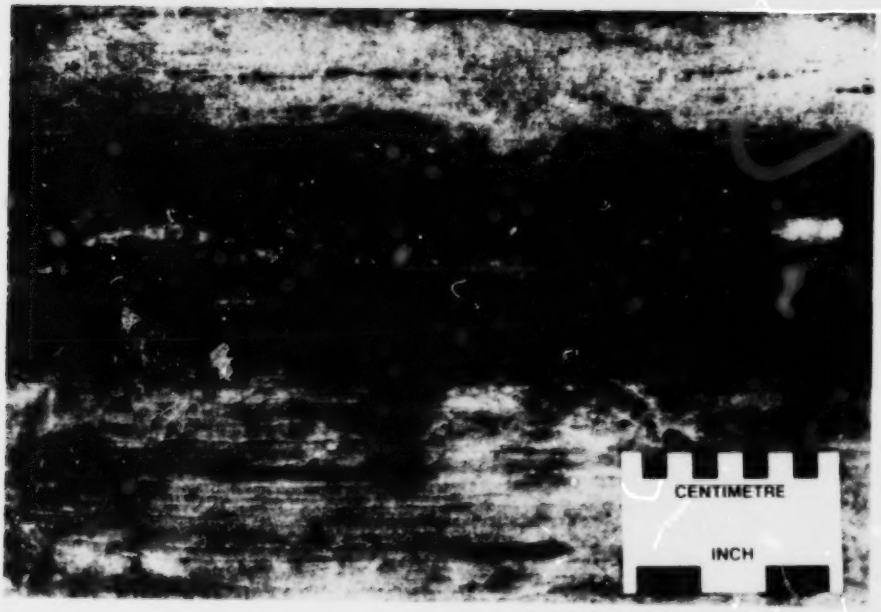

Photo 7. *Detail of magnetite layers with associated chlorite schist and discontinuous, concordant quartz veining within wacke. Near bend in Burrows River, 1 km north of Hutal Lake.*

Chlorite Schist

Chlorite schist is a minor component interlayered with the greywacke of the Hutchison Lake metasediments. The layers are thin (<10 cm), lack graded bedding, are laterally persistent, and weather recessively. The areal distribution of the chlorite schist is similar to that of the magnetite layers (and concordant quartz veining) with which it is commonly associated.

The chlorite occurs as anastomosing, fibrous mats and disseminations in a quartzofeldspathic matrix. Anhedral plagioclase grains up to 1 mm in diameter exhibit weak to moderate epidote alteration. The remainder of the quartzofeldspathic matrix is finer grained (<0.2 mm). Other components of the matrix include epidote, biotite, and carbonate. These layers have been intensely sheared and primary textures obliterated.

The origin of these layers is not clear but they probably represent either silicate facies ironstone or a tuff.

Volcan Lake Metasediments (Conglomeratic Association)

The outcrop area of the Volcan Lake metasediments is restricted but excellent exposures occur on a *roche moutonee* that rises prominently above the surrounding glacial outwash plains in southeast Kirby Township. Smaller outcrops occur along strike to the east and west of the major outcrop area. Bruce (1935, p.13 and p.18) described this conglomerate and concluded that these rocks, along with wacke to the south of the present map area, were "probably stream-carried and deposited in coalescing piedmont fans". Macdonald (1943) noted their general compositional characteristics but did not comment on their depositional environment. R.M. Callander (1970) described similar conglomerate between the present map area and Lake Nipigon.

The Volcan Lake metasediments are conglomeratic with subordinate, interlayered arenaceous beds (Figure 11). The layering generally strikes east and has

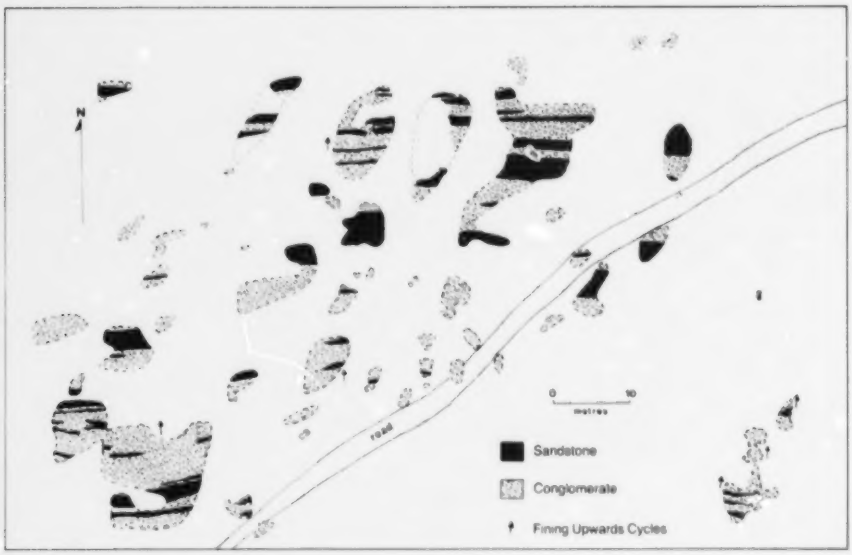

Figure 11. *Geological map of part of Volcan Lake conglomerate outcrop located near the top of a prominent roche moutonee in the southeastern corner of Kirby Township.*

steep to intermediate dips to the north. Although numerous faults with displacements of a few centimetres are present, no major repetition of the section due to faulting or folding is present and the package is a northward facing, homoclinal sequence with a minimum stratigraphic thickness of 125 m.

The conglomerates are polymictic (Table 3; Photo 8) with the most abundant types of clasts being felsic metavolcanics, felsic hypabyssal porphyries, and mafic metavolcanics. Lesser amounts of chert and felsic plutonic rock fragments are present along with trace amounts of mafic plutonic rocks, magnetite-chert ironstone, vein quartz, and sulphide minerals. The only type of lithology typically present in Early Precambrian greenstone belts that is conspicously lacking from this clast assemblage are clastic metasediments of the turbidite association. This absence could be due to either the turbiditic metasediments postdating the conglomerate or, more likely, the absence of these rocks in the source area of the conglomerates (possibly because they represent the distal facies equivalent).

In general, there is a continuous gradation in fragment size from the coarsest fragment in a given layer to the medium to coarse sand matrix. Boulders (>256 mm) are rare and maximum clast size is usually in the cobble range (64 to 256 mm) although numerous distinctive pebble beds are present that contain no cobbles or boulders.

The conglomerates are mostly clast-supported but, with increasing sand component, these rocks grade into matrix-supported conglomerate and pebbly sandstone. The arenaceous matrix of the conglomerates is texturally and compositionally similar to those sandstones described below.

The various lithological types of clasts have responded differently to the deformation that has been imposed on the rocks. Felsic porphyries and plutonic rocks have apparently been little deformed. Where these clasts can be observed in three dimension or picked out of the outcrop, they are nearly perfectly spherical. They have been rotated and locally have suffered brittle failure, but they essentially preserve their primary shapes. Mafic volcanic clasts, on the other hand, are highly stretched and bend around more competent clasts. Where deformation is

TABLE 3. RESULTS OF PEBBLE COUNTS FOR 2 LOCATIONS WITHIN THE VOLCAN LAKE METASEDIMENTS IN THE GRENVILLE LAKE AREA.

Clast Type	Volume of Clasts (In percent) No.1	No.2
Felsic Metavolcanics	43.5	56.5
Mafic Metavolcanics	35.5	26.6
Felsic Porphyry	17.2	5.5
Granitoids	2.8	11.0
Black Chert	0.6	0.4
Red Chert	0.4	
Percent Matrix	41.8	28.8
Number of Counts	861	333

Pebble count No. 1 by G.P. Beakhouse
Pebble count No. 2 by J.R. Devaney

Note: The volume of different types of clasts is calculated by subtracting the matrix and re-calculating to 100 percent.

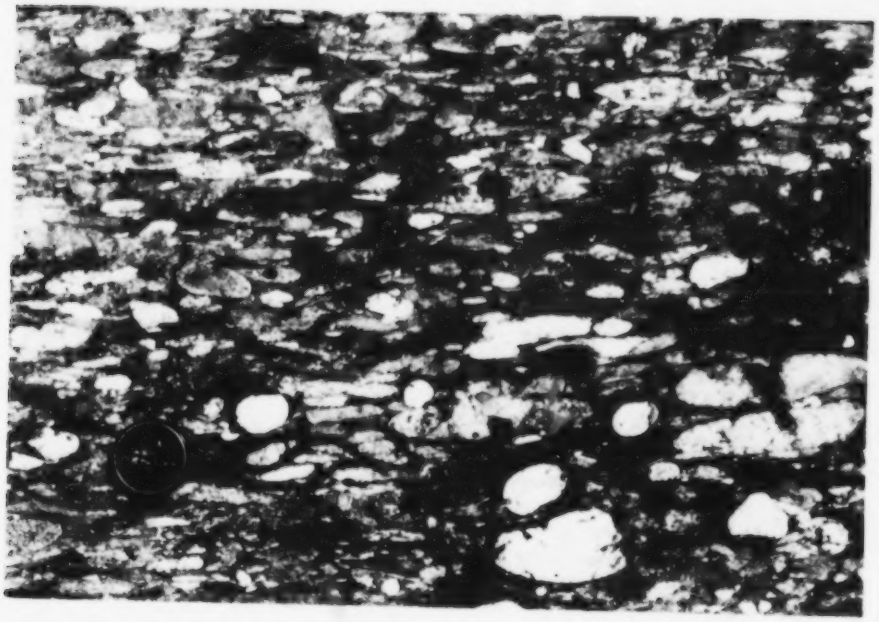

Photo 8. *Polymictic conglomerate. Note the differential flattening of the clasts. Near Volcan Lake.*

particularly intense, these fragments can have length to width ratios of 10:1 and can be difficult to distinguish from the matrix. Felsic volcanic clasts display a response intermediate between that of the porphyries and mafic volcanic rocks.

Feldspathic and lithic arkose (see discussion below) constitute approximately 15 to 25 percent of the entire sequence (Photo 9). In outcrop, these rocks are grey on fresh surface and weather to a buff to light brown colour. Most are massive but

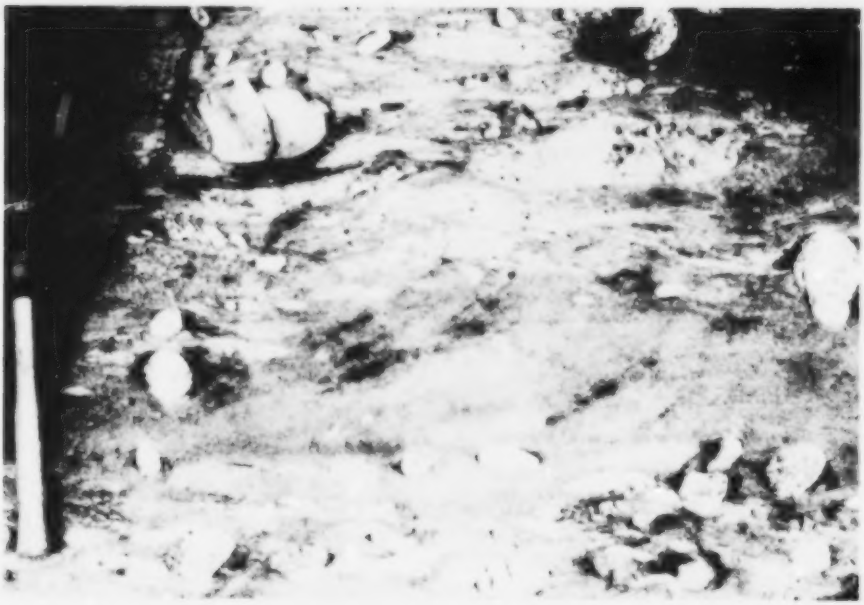

Photo 9. *Sand lens in polymictic conglomerate. Note the differential deformation of clasts. Near Volcan Lake.*

a small percentage have laminations (<1 cm) defined by variations in grain size, colour of weathered surface, and subtle mineralogical variation.

Examination of thin sections reveals that these rocks have been little deformed and many grains preserve primary equant, angular morphologies (Photo 10). The most conspicuous grains are composed of plagioclase, quartz, or cherty rock fragments. Also abundant (Table 4) but more difficult to distinguish from the matrix are flattened volcanic rock fragments. Other detrital fragments identified are composed of myrmekite, microcline, epidote, sphene, and zircon. Secondary minerals include muscovite and chlorite associated with the alteration of feldspar, lithic fragments, and matrix as well as carbonate and euhedral, cubic pyrite crystals.

The matrix of these sandstones is composed of fine-grained quartz and feldspar with minor sericite and epidote. This matrix composes between 9.5 and 16.8 percent of the rock (see Table 4) and, on this basis, two of the samples could be classified as wacke (>15 percent matrix). It is possible that some of the "matrix" is highly recrystallized rock fragments and, for this reason as well as to distinguish them from the distinctly more pelitic wacke of the Hutchison Lake metasediments, all these rocks are referred to as arkose.

Internal stratigraphy within the Volcan Lake metasediments tends to be rather chaotic. Well-defined arkose and pebbly conglomerate layers are common but are laterally discontinuous (see Figure 11). Thick conglomerate beds when examined in detail commonly have abundant crude bedding indicating that they are, in fact, composite. Fining upward sequences, scours, and large-scale, low-angle cross-stratification indicate tops to the north. The arkoses typically have irregular, gradational bases, and sharp tops and lack any conspicuous internal structures (graded bedding, small-scale crossbedding) other than parallel laminations. Some of these thin parallel laminations have a rusty weathered surface and contain relatively abundant magnetite, pyrite, epidote, sphene, and zircon. All of these, with the exception of pyrite, represent original detrital concentration of heavy minerals. Some of the thin pebble bands in the sandy units may represent lag deposits.

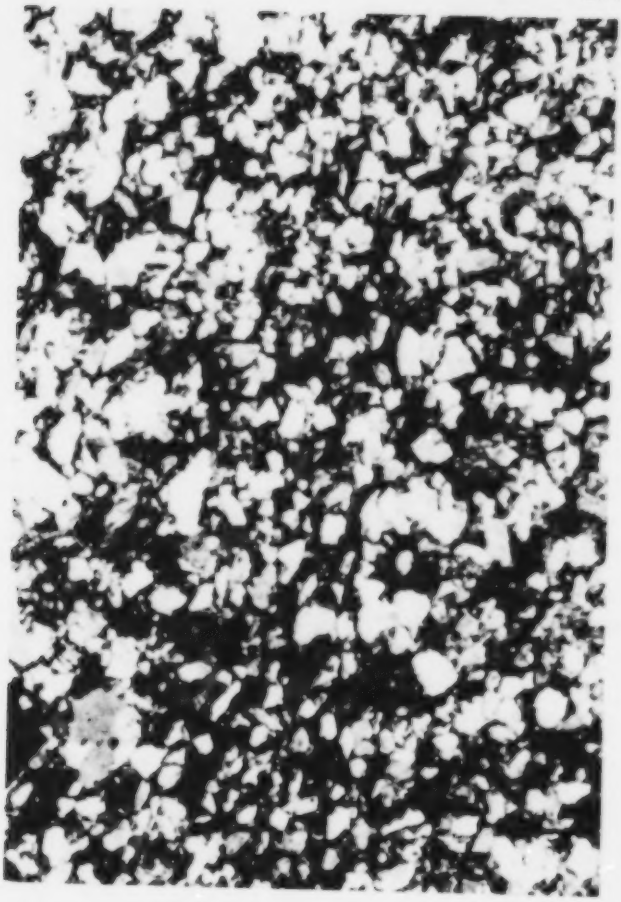

Photo 10. *Photomicrograph (plane polarized light) of the texture of arenite, Volcan Lake metasediments. Extreme southeast corner of Kirby Township.*

The principal environments in which coarse clastic sediment occur are fluvial deposits, submarine fan deposits, and glacial (till) deposits. The latter possibility is unlikely for the Volcan Lake metasediments. There is no evidence elsewhere in the Superior Province for glacial deposits of Early Precambrian age. Further, the absence of fine-grained detritus and presence of crude sorting and stratification is inconsistent with these deposits being tills. The choice between the former two environments of deposition would best be made by establishing lateral facies changes but the limited outcrop in the area precludes this. The characteristics of the Volcan Lake metasediments are more consistent with those of a fluvial environment (Miall 1977; Rust 1979) than those of a submarine fan environment (Walker 1979). In particular, the predominance of clast-supported conglomerate, the presence of heavy mineral concentration, and the absence of turbidite or shale are difficult to reconcile with a submarine fan depositional environment. The complex interplay of erosional and depositional processes in a fluvial environment can best explain the complex internal stratigraphy of the Volcan Lake metasediments.

A Comparative Analysis of the Metamorphosed Arenaceous Rocks in the Grenville Lake Area

The metamorphosed sandstones in the Hutchison Lake metasediments and Volcan Lake metasediments are compositionally distinct and were deposited in different

TABLE 4. MODAL ANALYSES OF ARENITES FROM THE VOLCAN LAKE METASEDIMENTARY BELT IN THE GRENVILLE LAKE AREA. MODAL ANALYSES ARE BASED ON 1000 COUNTS OF STANDARD THIN SECTIONS.

Sample		126	128B	128D	128E	128G
Plagioclase		24.4	21.2	31.5	29.9	26.0
Quartz		35.6	29.4	27.5	29.2	25.0
K-Feldspar		0.3	0.2	-	-	0.1
Epidote		1.6	0.3	1.3	2.1	
Pyrite		1.1	0.8	0.9	0.7	1.4
Carbonate		-	0.1	-	0.3	tr
Sphene		-	-	0.1	1.1	tr
Zircon		-	-	0.1	0.1	tr
Muscovite		-	-	tr	0.1	-
Chlorite		0.4	-	-	-	-
Plagioclase/Quartz Ratio		0.69	0.72	1.15	1.02	1.04
	Felsic Volcanic	18.3	22.0	11.0	12.9	18.0
Lithic	Mafic Volcanic	1.6	5.0	4.5	4.5	16.0
Fragments	Chert	2.0	4.1	6.5	6.0	4.0
	Myrmekite	0.1	0.1	tr	-	-
matrix		14.6	16.8	16.6	13.1	9.5

TABLE 5. RATIO OF PLAGIOCLASE/QUARTZ IN THE SAND-SIZE FRACTION FOR ARENITES FROM THE HUTCHISON LAKE METASEDIMENTARY BELT IN THE GRENVILLE LAKE AREA BASED ON 200 TO 300 COUNTS OF RECOGNIZABLE SAND-SIZE GRAINS IN THIN SECTION.

Sample	Plagioclase/Quartz
24C	2.28
24D1	1.67
24F	2.45
25A	3.17
246B	2.10

depositional environments but this does not rule out the possibility that the two groups of metasediments could be related. For example, the braided fluvial deposits (Volcan Lake metasediments) may represent the proximal facies and the turbidite deposits (Hutchison Lake metasediments) may have been deposited on submarine depositional fans where these fluvial systems discharge into marine or large lacustrine basins. It is clearly desirable to demonstrate such a relationship, if it exists, by tracing one environment laterally into the other in the field. In the Grenville Lake area, the insufficient exposure and presence of structural complications (Burrows River Fault) preclude such an approach. The purpose of this section is to present petrographic observations that are relevant to this problem.

H. Blatt *et al.* (1972) pointed out that the mineralogical maturity of a clastic sediment is a function of alteration and weathering of the source rock, abrasion during transport, and diagenetic alteration. The consequences of this sedimentary differentiation are to produce detritus that becomes progressively enriched in minerals and rock fragments that are more resistant (quartz, chert) and depleted in those that are less resistant (feldspar, labile rock fragments). The latter group are

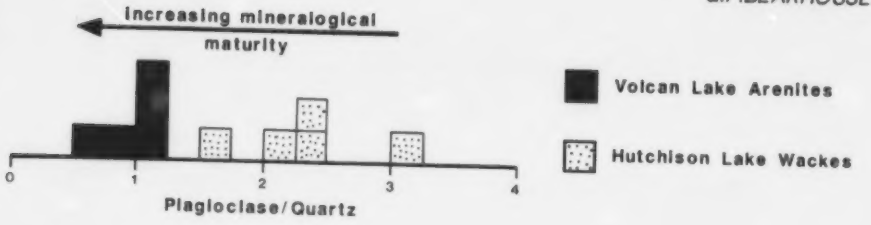

Figure 12. *Comparison of the plagioclase/quartz ratio in sandstone of the Hutchison Lake metasediments and Volcan Lake metasediments. Data and analytical methods are presented in Tables 4 and 5.*

largely transformed to clay minerals and the ultimate products of this process are quartzite and shale. The difficulty in distinguishing rock fragments from matrix in metamorphosed sandstone (particularly wacke) precludes their use in estimating the mineralogical maturity. One observation, that reflects in part, mineralogical maturity, and can be readily determined in these rocks is the ratio of plagioclase to quartz. This ratio was determined from modal analyses of the Volcan Lake arenites and partial modal analyses of the Hutchison Lake wackes (Tables 4 and 5). The only grains counted in the wackes were those of approximately the same size as those in the arenites in order to reduce any bias introduced by counting different grain sizes (Blatt *et al.* 1972). The resultant ratios are thought to closely reflect the original detrital mineralogy. If any component is likely to be underestimated as a result of recrystallization obscuring original detrital grains, it is likely to be the plagioclase component of the wackes. This would have the effect of decreasing the plagioclase to quartz ratio and making these rocks appear more mineralogically mature.

The plagioclase to quartz ratio is distinctly different for the two groups of sandstone (Figure 12; Tables 4 and 5). The greater abundance of plagioclase relative to quartz for the Hutchison Lake wackes is incompatible with these rocks being a distal equivalent of the Volcan Lake metasediments. If this were the case, it would require that plagioclase be enriched relative to quartz in the sedimentary environment. This is unlikely and it is tentatively concluded that these two groups of metasediments are not closely related.

Chemical analyses of metasediments (Table 6; Figure 13) reflect the mineralogical characteristics summarized above. The relatively Al_2O_3 and alkaline earth-rich character of the wackes reflects the predominance of plagioclase and phyllosilicates in these rocks. The geochemical character of the arenites is due to a different provenance and greater sedimentological maturity resulting in higher SiO_2 and a concomitant decrease in other elements because of dilution.

A major weakness of this argument is that the compositions are determined from geographically restricted areas and could reflect local conditions. This is especially true for the fluvial deposits in which local provenance can result in profound differences in detrital mineralogy. Future studies should deal with regional scale variations in composition (is there quartz-rich wacke? e.g. Donaldson and Jackson 1965) and depositional environments. Emphasis should be placed on areas where one type of environment grades laterally or vertically into the other.

Chemical Metasediments

The principal occurrences of chemical metasediments are in the central part of the Kirby Lake metavolcanics and the eastern part of the Hutchison Lake metasediments. The iron-rich metasediments (magnetite layers) from the latter environment have been discussed along with the clastic metasediments with which they are intimately associated and will not be considered here.

A laterally persistent ironstone horizon can be traced on aeromagnetic maps (Ontario Division of Mines-Geological Survey of Canada 1974a,b,c,d) through the central part of the Kirby Lake metavolcanic unit from central Kirby Township to the northeastern part of McQuesten Township. Numerous thin ironstone, ferruginous

TABLE 6. CHEMICAL ANALYSES OF METASEDIMENTS FROM THE GRENVILLE LAKE AREA. ANALYSES 24 TO 28 ARE WACKES FROM THE HUTCHISON LAKE METASEDIMENTS AND 29 TO 33 ARE ARENITES FROM THE VOLCAN LAKE METASEDIMENTS. SAMPLE LOCATIONS ARE ILLUSTRATED IN FIGURE 4. MAJOR ELEMENTS ARE REPORTED AS WEIGHT PERCENT OF THE OXIDE AND TRACE ELEMENTS AS PPM EXCEPT WHERE NOTED PPB.

Analysis Number	24	25	26	27	28	29	30	31	32	33
Field Number	24C	24F	25A	33	246B	126	128B	128C	128D	128G
SiO_2	66.4	67.3	66.6	59.00	63.00	73.30	69.30	62.20	70.10	68.20
TiO_2	0.42	0.37	0.36	0.52	0.64	0.38	0.55	0.69	0.43	0.47
Al_2O_3	16.20	16.40	16.40	14.50	16.00	12.00	12.90	14.50	12.40	12.40
Fe_2O_3	1.20	0.69	0.88	1.53	0.17	1.11	1.61	1.35	1.14	1.29
FeO	3.07	2.26	1.61	4.31	4.38	2.56	4.09	4.53	3.29	4.02
MnO	0.05	0.04	0.08	0.09	0.05	0.06	0.08	0.09	0.08	0.09
MgO	1.23	1.05	0.76	5.14	3.56	1.15	2.47	2.29	1.86	1.71
CaO	2.27	2.54	3.82	6.22	1.11	2.78	2.37	3.14	3.15	2.69
Na_2O	3.75	4.94	4.15	3.01	4.95	3.21	2.96	3.32	3.08	2.96
K_2O	2.47	1.76	2.00	1.87	1.60	1.23	1.14	1.45	1.29	1.60
P_2O_5	0.08	0.09	0.09	0.06	0.15	0.06	0.10	0.13	0.09	0.07
CO_2	0.71	0.82	1.84	1.06	0.22	0.77	0.13	2.39	1.36	1.55
S	0.04	0.09	0.08	0.03	0.01	0.02	0.06	0.08	0.07	0.20
H_2O^+	1.45	0.99	0.99	1.33	2.15	1.37	1.94	2.39	1.69	1.85
H_2O^-	0.06	0.06	0.03	0.04	0.05	0.04	0.06	0.06	0.04	0.03
Total	99.40	99.40	99.69	98.71	98.64	100.04	99.76	98.61	100.07	99.13

TABLE 6 cont'd.

Analysis Number	24	25	26	27	28	29	30	31	32	33
Field Number	**24C**	**24F**	**25A**	**33**	**246B**	**126**	**128B**	**128C**	**128D**	**128G**
Rb	80	60	60	50	40	30	20	40	30	40
Sr	430	400	390	440	395	155	145	185	190	85
Li	15	15	18	18	24	14	20	20	14	18
Ba	660	550	680	540	510	310	300	430	370	350
Ce	35	35	<35	40	100	40	<35	40	40	80
Nd	<30	<30	<30	30	50	<30	<30	<30	<30	45
Y	4	3	4	6	10	6	7	5	6	10
Co	10	11	12	25	16	10	18	19	16	17
Cr	55	40	48	168	99	77	88	76	80	97
Cu	20	25	29	50	34	30	46	54	34	40
Ni	23	18	22	110	79	30	45	44	36	40
Pb	66	305	220	144	<10	<10	<10	82	<10	<10
V	60	50	55	120	100	70	105	100	85	90
Zn	40	64	50	76	78	41	62	55	49	58
Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
As	30	50	40	110	140	130	170	70	110	70
Au(ppb)	5	<2	3	<2	<2	<2	2	40	4	195

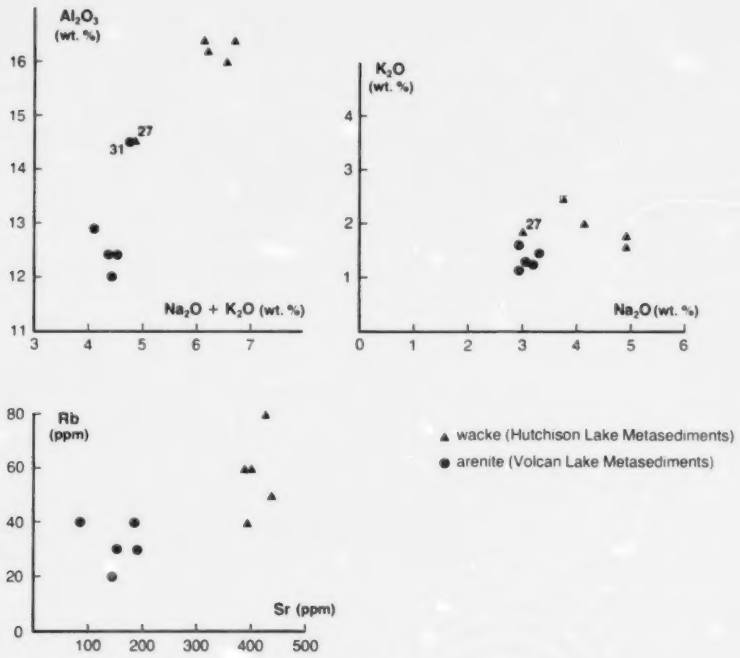

Figure 13. *Binary plots for metasedimentary rocks from the Grenville Lake area.*
a) Al_2O_3 vs. $Na_2O + K_2O$
b) K_2O vs. Na_2O
c) Rb vs. Sr

chert, and chert horizons are interlayered with mafic flows within 200 m of this zone. The main ironstone horizon is locally up to 10 m thick. The main or secondary ironstone has been observed in outcrop northwest of Kirby Lake, at Kirby Lake, north of Hutchison Lake, and southwest and east of McQuesten Lake. Ironstone has also been intersected by diamond drilling east of Kirby Lake, north of Grenville Lake, south of McQuesten Lake, and in northeastern McQuesten Township.

These rocks range from true ironstone (massive magnetite or magnetite interlayered with chert) to ferruginous chert and chert. The rock is described as an ironstone if magnetite is present in amounts great enough to suggest that the rock might have more than 15 percent Fe (Gross 1965). Chert occurs both as a red (jasper) and white variety. Sulphide minerals are commonly present as disseminated, euhedral pyrite crystals. Logs for diamond-drill holes from the eastern half of McQuesten Township indicate that in this area abundant disseminated, stringer, and massive sulphide mineralization is associated with the ironstone. The sulphide minerals are mainly pyrite and pyrrhotite but minor chalcopyrite, sphalerite, and arsenopyrite are also reported.

In one outcrop at the east end of a small lake that is located 1.4 km northwest of the west end of Kirby Lake, the ironstone occurs as massive magnetite and magnetite with minor chert.

Elsewhere, as for example in outcrops 2.2 km north of the west end of Hutchison Lake and 2.4 km east of the south end of McQuesten Lake, magnetite layers are interlayered with chert. Individual layers are thin (<2 cm) and uniform in thickness although minor folds and faults at a small angle to bedding are common. A thin section from the latter outcrop reveals that the banded chert-magnetite ironstone is composed principally of magnetite, quartz, and grunerite. Both the quartz and magnetite occur as fine grains (<0.1 mm) with the latter occurring both in discrete, monomineralic layers and as disseminations in the quartz. Grunerite occurs as fibrous aggregates with individual crystals up to 2 mm long. Minor secondary pyrite, carbonate, and chloritic alteration of grunerite are present.

Chert, without associated ironstone, occurs as thin (<2 m) units interlayered with mafic flows. Examination of one thin section of such a chert reveals that it is composed principally of very fine grained (<0.02 mm) quartz with subordinate carbonate and minor pyrite, hematite, and apatite. The carbonate occurs both as finely granular, "dirty" layers and as a coarse sparry variety in discordant veins.

A sulphide-rich (pyrite and pyrrhotite) ironstone is interpreted to occur in the Dionne Lake metavolcanics at the east end of Dionne Lake on the basis of a weak aeromagnetic anomaly and a diamond-drill hole log filed for assessment credit (see Canadian Nickel Company Limited-Dionne Lake [1971] Property No. 8 under Description of Properties).

MAFIC INTRUSIVE ROCKS

Metamorphosed mafic intrusive rocks occur principally as sills in the eastern part of the Kirby Lake metavolcanics. Minor amounts of this rock type occur north of Kirby Lake and southeast of Hutal Lake. This unit is distinguished with difficulty from medium grained mafic flows. Those rocks designated as mafic intrusive rocks on the accompanying map (back pocket) are distinguished from the medium-grained basalt flows on the basis of coarser grain-size, presence of fine-grained amphibolite inclusions, intrusive relationships, and very narrow chilled margins. Medium-grained mafic rocks of indeterminate origin are included in the mafic metavolcanics (1f).

These rocks are black on both fresh and weathered surfaces. Knobby weathered surfaces, due to amphibole being more resistant to erosion than plagioclase, are common among the coarser grained varieties. The rocks are massive and equigranular with grain size in the range from 2 to 10 mm except at chilled margins where the size grades down to aphanitic. Crystals tend to be subhedral and equant and the rocks generally lack the good penetrative foliation that characterizes the mafic metavolcanics.

In thin section, the rocks are composed principally of plagioclase and amphibole in approximately equal amounts. Minor quartz and opaque minerals are present. Secondary alteration of plagioclase to sericite, epidote, and carbonate, and amphibole to chlorite is present but not nearly as pervasive as for the finer grained mafic metavolcanics. Secondary quartz and/or carbonate veining is rare.

GRANITOID ROCKS (6, 7, 8)

Granitoid rocks underlie approximately the northern one third of the map area. These rocks occur along the southern margin of a large batholithic complex (Pye *et al.* 1966) that has never been mapped in detail.

Granitoid rocks were subdivided into three units in the field on the basis of texture, composition, and relative age. Each of these units contains numerous phases but all have characteristics that distinguish them from the other units (Table 7).

Crosscutting relationships consistently indicate that the recrystallized, foliated to lineated, tonalitic to granodioritic phases are older than the massive, microcline-megacrystic granodioritic to granitic phases which, in turn, are older than the massive, equigranular granitic phases. The later two phase groups are not recrystallized or deformed except in late shear zones and are interpreted to postdate the main regional deformation. The late sheared zones tend to occur in areas with

TABLE 7. CHARACTERISTICS OF THE 3 FELSIC PLUTONIC UNITS IN THE GRENVILLE LAKE AREA.

Phase	Composition Range	Texture	Structure	Relative Age
Early pretectonic to syntectonic	Tonalite to granodiorite	Equigranular	Foliated to lineated	Oldest
Megacrystic late to posttectonic	Granodiorite to granite	Megacrystic*	Massive** non-foliated	
Equigranular late to posttectonic	Granite	Equigranular	Massive** non-foliated	Youngest

Notes
*anhedral to euhedral microcline megacrysts
**except weakly to strongly foliated in late shear zones

abundant inclusions where the deformation and complex intrusive history results in migmatitic zones and in the vicinities of the contacts of the stocks.

Early, Pretectonic to Syntectonic Phase (6)

Foliated tonalite to granodiorite occurs in a 500 to 3000 m wide belt that is present along the northern contact of the Kirby Lake metavolcanic belt. This belt extends from north-central McQuesten Township to North Kirby Lake and possibly continues along the greenstone-granitoid interface southwest of North Kirby Lake but outcrops are lacking in this area. A smaller area of exposure of similar rocks occurs to the north of this belt along the southeast shore of Wildgoose Creek in northwestern Fulford Township.

These rocks intrude the adjacent greenstone sequence and contain numerous amphibolitic inclusions thought to represent recrystallized basalt. The distributions of the inclusions are heterogeneous with most being in distinct migmatitic zones (see below). The later megacrystic and equigranular phases are intrusive into the foliated tonalite and granodiorite.

The mineralogical and chemical composition of these rocks is portrayed in Figure 14 and Tables 8, 9, and 10. Plagioclase is predominant and in the few thin sections examined, its composition lies in the range An_{25-30}. Albite twinning is well developed in most rocks, but in highly deformed varieties twinning is poorly developed. Zoning in plagioclase is evident in some samples. The intensity of sericitic alteration is low to moderate overall but is heterogeneous within individual grains with local intensely altered zones. Quartz occurs as anhedral grains with undulatory to patchy extinction. Microcline, if present, occurs as interstitial anhedra with well-developed cross-hatched twinning. Biotite with planar to ragged terminations is the predominant mafic mineral and commonly displays incipient chloritization. Minor hornblende is present in some rocks. Minor amounts of epidote are ubiquitous and occur both as fine-grained, granular masses associated with the deuteric alteration of plagioclase and as larger, possibly primary magmatic crystals. Muscovite occurs as the fine-grained, shreddy variety sericite associated with plagioclase alteration and, less commonly, as larger (<1 mm) grains. Euhedral sphene, apatite, and zircon and subhedral magnetite are common accessory minerals. Trace amounts of carbonate are present as interstitial grains and late fracture filling.

The original igneous texture of these rocks has been modified by recrystallization under directed stress with the attendant development of a mineral foliation and lineation. The foliation is most obviously manifest as alignment of biotite flakes but flattening and alignment of quartz and/or feldspar also occurs.

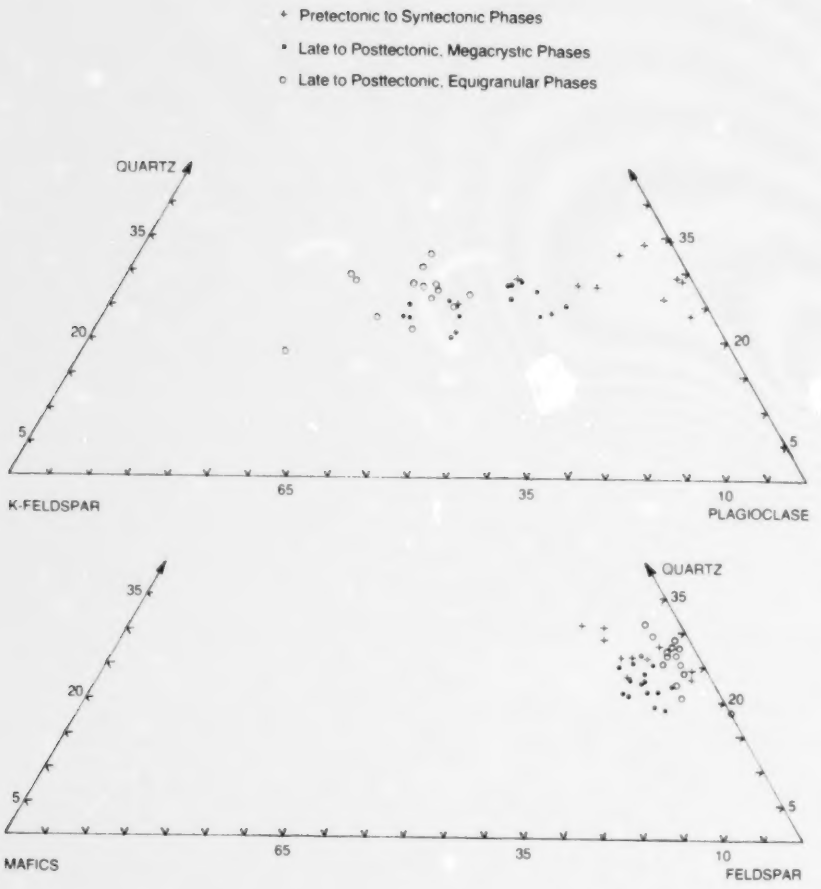

Figure 14. *Modal mineralogy of granitoid rocks of the Onaman-Twin Lakes batholith in the Grenville Lake area.*

Ribbon Quartz Phase (6b)

A distinctive rock type is characterized by the presence of intensely flattened quartz grains referred to here as ribbon quartz. Ribbon quartz is developed in rocks of granodioritic to tonalitic composition and occurs most commonly near the southern contact of this unit with the metavolcanic sequence. This textural feature of the ribbon quartz is especially well developed south of Papineau Lake, southwest of McQuesten Lake, and between Kirby and North Kirby Lakes.

Mineralogically, this rock is similar to others in the unit but its distinctive textural differences arise because of the intense flattening and recrystallization to which these rocks have been subjected. Platy quartz grains up to 1 cm long with a diameter to thickness ratio of 10:1 now consist of numerous separate crystals with various optical orientations. Plagioclase exhibits similar characteristics to a lesser extent. Albite twinning is not so well developed and more of the muscovite associated with this plagioclase is the coarser grained variety. An extremely well-developed biotite foliation parallels the elongation of quartz and feldspar.

This phase is interpreted to be a highly deformed equivalent of the rest of this unit and its occurrence along the greenstone belt contact suggests that either a stress gradient is associated with this contact or that the border phases of this unit

TABLE 8. DETAILED MODAL ANALYSES OF SELECTED GRANITOID ROCKS FROM THE ONAMAN-TWIN LAKES BATHOLITH IN THE GRENVILLE LAKE AREA BASED ON 1000 COUNTS OF STANDARD THIN SECTIONS.

Sample No.*	144	231A	169	177A	177B	195	231B
Map Unit	6	6	7	7	8	8	8
Quartz	28.4	24.3	20.4	20.3	20.4	26.0	18.3
Plagioclase	50.3	64.8	40.5	61.4	36.7	26.4	25.3
K-Feldspar	3.1	0.2	29.9	12.9	35.9	38.6	55.2
Hornblende	-	-	0.3	0.1	-	-	-
Biotite	12.3	9.3	3.8	4.2	3.6	4.8	0.2
Muscovite	1.4	0.2	tr	tr	1.2	1.4	0.4
Chlorite	0.4	-	-	0.2	1.2	tr	-
Epidote	3.2	1.0	0.8	0.2	0.7	2.0	0.3
Myrmekite	-	-	3.8	0.4	0.3	0.3	0.2
Opaque	0.1	0.1	0.1	0.1	tr	0.4	0.1
Sphene	0.4	0.1	0.3	0.2	0.3	tr	-
Apatite	0.3	tr	0.1	tr	0.1	tr	-
Zircon	0.1	tr	tr	tr	tr	0.1	-
Carbonate	tr	tr	-	-	-	-	-

Note
*All sample numbers are preceded by GBP-82-.

were emplaced first and suffered flattening before the emplacement of subsequent phases.

Megacrystic, Late to Posttectonic Phase (7)

Felsic plutonic rocks characterized by the presence of subhedral, poikilitic microcline megacrysts occur in two separate areas. One of these, in the northern part of Kirby Township, is referred to as the Edgewood Lake stock and the other, in northwestern McQuesten and northeastern Fulford Township, as the Papineau Lake stock. These bodies are called stocks on the basis of their areal extent in the map area but both extend outside the map area and are undoubtedly much larger and may, in fact, be part of the same body.

This unit is intermediate in age relative to the other two felsic plutonic units. It is intrusive into the foliated, equigranular tonalite to granodiorite and cut by the equigranular granite. Inclusions within the megacrystic unit include amphibolite (1h), variously deformed tonalitic to granodioritic plutonic rocks and biotitic *schlieren*. Most of this unit lacks a tectonic foliation and evidence of recrystallization and is interpreted to postdate the main regional deformation. Locally, a moderately to well-developed foliation is present (Photo 11). This phenomenon is most conspicuous and areally extensive in two separate zones: (1) the northeastward trending migmatite zone east of North Kirby Lake and (2) the southern margin of the Papineau Lake stock. These foliated zones are interpreted to be late shear zones that postdate the main regional deformation.

Plagioclase is the most abundant mineral and typically shows localized, intense patches of sericitization. Zoning is evident in some grains and twinning is poorly developed preventing a reliable estimate of the plagioclase composition which is thought to be in the range An_{20-30}. Quartz occurs as interstitial anhedra with undulatory to patchy extinction.

The mineralogical composition of this unit is remarkably uniform and variations arise mainly from the distribution of microcline megacrysts resulting in granodiorite to granitic compositions. Microcline occurs both as megacrysts and smaller interstitial anhedra. The megacrysts are up to 5 cm in longest dimension but are most commonly 1 to 2 cm. The megacrysts are anhedral to subhedral, exhibit minor perthitic exsolution, and poikilitically enclose virtually every other mineral in the

TABLE 9. MODAL ANALYSES OF GRANITIC ROCKS FROM THE GRENVILLE LAKE AREA.

Sample Number	Quartz	Plagioclase	K-Feldspar	Mafic Minerals
Pretectonic and syntectonic equigranular phases				
GPB-82-74	26.1	62.6	1.2	10.1
GPB-82-82*	24.4	42.8	30.8	2.0
GPB-82-153	28.8	53.6	6.8	10.8
GPB-82-234A	20.8	54.8	4.0	9.4
GPB-82-1020	30.8	56.2	0.4	12.6
GPB-82-1047*	26.2	45.0	20.2	8.6
GPB-82-1086A	26.0	53.4	13.8	6.8
GPB-82-1127	28.0	65.8	1.8	4.4
GPB-82-1128	27.2	58.2	12.4	2.2
Late to posttectonic, megacrystic phases				
GPB-82-76	21.2	34.2	35.4	9.2
GPB-82-85A	24.8	43.2	21.0	11.0
GPB-82-150	22.8	34.3	34.2	8.7
GPB-82-160A	20.9	48.9	17.8	12.4
GPB-82-163	25.2	49.0	19.2	6.6
GPB-82-164	20.7	48.3	19.3	11.7
GPB-82-1042	21.3	35.5	35.4	7.8
GPB-82-1043A	22.0	42.0	30.2	5.8
GPB-82-1051	23.8	39.2	30.0	11.0
GPB-82-1052	18.6	41.4	31.8	8.2
GPB-82-1073A	22.6	52.0	16.2	9.2
GPB-82-1074	19.0	41.0	30.6	9.4
GPB-82-1077	25.4	44.4	21.2	9.0
Late to posttectonic equigranular phases				
GPB-82-85B	28.8	27.4	41.8	2.0
GPB-82-160B	23.4	35.8	30.8	2.8
GPB-82-173B	26.4	38.8	31.8	3.0
GPB-82-186	22.2	32.6	40.2	5.0
GPB-82-194	26.6	36.4	33.0	4.0
GPB-82-234B	18.3	25.3	56.4	0.0
GPB-82-1043B	27.1	35.1	34.1	3.8
GPB-82-1076	27.5	38.5	32.0	2.0
GPB-82-1086B	24.0	41.8	31.0	3.2
GPB-82-1093	29.3	34.7	31.5	4.5
GPB-82-1094	31.0	34.8	29.6	4.6
GPB-82-1118	25.2	42.0	27.6	5.2

*ribbon texture

rock. Plagioclase inclusions typically have sericitized cores and an unaltered, (albitic?) rim. Megacryst development is also observed within small inclusions in this unit. The origin of such megacrysts has been considered elsewhere (Swanson 1977; Beakhouse 1983) and the aforementioned petrographic properties indicate that the megacrysts are neither phenocrysts nor porphyroblasts but rather represent late magmatic coalescence of microcline. The myrmekite development is also associated with this stage of magmatic evolution.

Biotite, commonly displaying incipient chloritization, is the predominant mafic mineral although traces of hornblende are present in some rocks. Epidote and muscovite occur as fine-grained granular and shreddy masses associated with the

TABLE 10. CHEMICAL ANALYSES OF FELSIC PLUTONIC ROCKS FROM THE GRENVILLE LAKE AREA. MAJOR ELEMENTS ARE REPORTED AS WEIGHT PERCENT OF THE OXIDE AND TRACE ELEMENTS AS PPM. SAMPLE LOCATIONS ARE ILLUSTRATED IN FIGURE 4.

Analyses Number	34	35	36	37	38
Field Number	144	231	169	177A	177B
SiO_2	67.90	71.60	70.60	71.00	72.20
TiO_2	0.54	0.29	0.27	0.32	0.23
Al_2O_3	15.40	15.40	15.80	15.30	15.20
Fe_2O_3	1.34	0.84	0.97	1.24	0.97
FeO	2.12	1.68	1.17	1.02	0.73
MnO	0.06	0.04	0.04	0.04	0.03
MgO	1.31	0.61	0.61	0.80	0.51
CaO	3.53	3.46	2.53	2.65	1.61
Na_2O	2.85	4.32	3.69	3.45	3.20
K_2O	2.37	1.04	3.50	3.40	4.14
P_2O_5	0.06	0.11	0.08	0.08	0.11
CO_2	0.30	0.07	0.08	0.06	0.08
S	0.02	0.01	0.01	0.01	0.01
H_2O^+	1.05	0.39	0.37	0.34	0.56
H_2O^-	0.04	0.03	0.04	0.03	0.04
Total	98.89	99.89	99.76	99.74	99.62
Rb	100	60	130	120	140
Sr	165	220	355	360	300
Li	30	43	30	30	22
Ba	570	120	650	630	620
Ce	85	70	115	110	120
Nd	35	40	50	55	50
Y	14	5	7	9	8

deuteric alteration of plagioclase. Euhedral sphene, zircon, and apatite are common accessory minerals.

The texture of this unit, although dominated by the presence of microcline megacrysts, is highly varied due to the degree of megacryst development and the intensity of a secondary foliation. The matrix, consisting predominantly of plagioclase, quartz, and biotite, has a typical hypidiomorphic granular texture. The megacrysts vary in size (<5 cm), in form (anhedral to subhedral, rarely approaching euhedral), and in the amount of poikilitically enclosed material. The massive variety shows no secondary preferred mineral orientations. With more intense shearing biotite develops a preferred orientation and megacrysts become tectonically rounded with their long axes parallel to the biotite foliation.

Posttectonic Equigranular Granite (8)

Massive, equigranular, medium-grained to pegmatitic granite is intrusive into the pretectonic to syntectonic tonalite and megacrystic posttectonic granodiorite. A comparatively large area in the vicinity of Wildgoose Creek in northeastern Kirby Township and northwestern Fulford Township is underlain by this unit. It is also common as dikes throughout the megacrystic unit (7), and, to a lesser extent, the foliated tonalitic to granodioritic unit (6).

The most abundant rock type included within this unit is medium-grained, equigranular, massive to foliated biotite granite. The relationship of this intrusive phase to deformation is similar to that of the megacrystic unit (7); emplacement postdates all but the last shearing event. The major outcrop area of this unit near

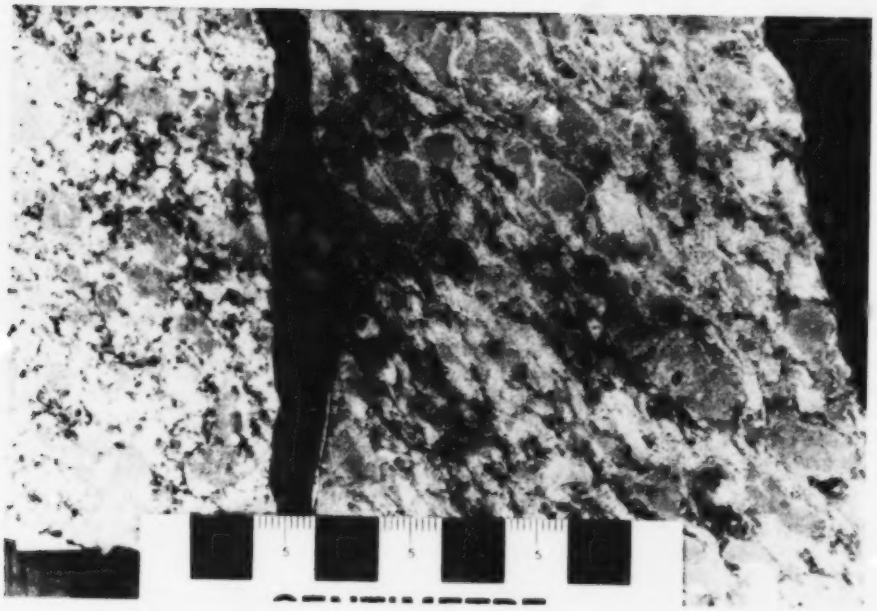

Photo 11. *Comparison of undeformed (left) and deformed (right) megacrystic granodiorite. The potassium feldspar megacrysts appear as a dark grey colour. Both samples are from north of the east end of Papineau Lake.*

Wildgoose Creek is within a major northeastward trending migmatitic shear zone so a high percentage of this unit is foliated.

All of the rocks within this unit are relatively leucocratic and are characterized by subequal amounts of plagioclase, microcline, and quartz. The plagioclase is subhedral to anhedral and is moderately to intensely sericitized. Twinning is not especially well developed and reliable measurements of composition are difficult to obtain. Quartz occurs as anhedra with undulatory extinction. Most of the microcline is present as anhedral, interstitial grains but some occurs as patches along the edge of or within plagioclase. The latter mode of occurrence may be due to replacement. Myrmekite is commonly developed adjacent to the microcline. Epidote and muscovite occur predominantly as fine-grained varieties resulting from the alteration of plagioclase although larger, discrete grains are also present. Chlorite is an alteration product of biotite. Euhedral sphene rarely exhibits partial to complete pseudomorphic replacement by an opaque phase. Zircon, apatite and magnetite are accessory phases.

A wide variety of textures characterizes the phases of this unit as a consequence of a wide variation in original igneous textures with a local superimposed deformational fabric. The undeformed, medium-grained, equigranular varieties display an hypidiomorphic granular texture with no preferred mineral orientations. These rocks frequently display an irregular, patchy grain size variation which in extreme examples results in diffusely bounded pegmatitic zones.

Pegmatitic and Aplitic Phase (8)

Late pegmatitic and aplitic dikes are included in unit 8 because of their late emplacement and granitic compositions. Pegmatitic dikes are common in the late to posttectonic felsic plutonic rocks, less common in the prekinematic to synkinematic plutonic rocks, and rare in the mafic metavolcanics near the contact with the granitoid rocks. This observation suggests a possible genetic link between the pegmatite and late to posttectonic plutonic rocks with the former being residual,

vapor-rich phases of the latter. Aplite is less common than pegmatite but is similarly distributed.

Several different relative ages of pegmatite generation are indicated by the presence of crosscutting relationships among dikes and both deformed and undeformed dikes in the sheared zone east of North Kirby Lake. The dikes have granitic compositions and rarely display a zoned structure with a quartz-rich interior.

A single pegmatite dike was examined petrographically and found to contain 99 percent quartz and feldspar. The plagioclase exhibits moderate to intense alteration to epidote and sericite. Microcline is unaltered, has minor perthitic exsolution and well-developed cross-hatched twinning, and has rare, oriented, elongate quartz inclusions that are thought to represent incipient development of a graphic texture. Epidote occurs as finely granular masses and muscovite both as a fine-grained shreddy variety and as larger (<0.2 mm).

Migmatitic Zones (6, 7, 8, 1h)

Amphibolitic inclusions are rarely present throughout all of the felsic plutonic units but several discrete zones are characterized by unusually abundant inclusions. The largest such zone has a northeastward trend with the southwest end occurring at the termination of a volcanic promontory into the granitic complex north of Kirby Lake (see Figure 3). A second, smaller zone with a similar trend located southeast of Wildgoose Creek may represent a part of the larger zone that was wedged apart by the emplacement of the youngest plutonic unit (8).

The geology of these migmatitic zones is exceedingly complex because, in addition to the heterogeneity introduced by the presence of inclusions, these zones are also loci of late shearing and small-scale intrusive activity. Typically, amphibolitic inclusions in these zones constitute between 2 and 10 percent of individual outcrops but abundances of 50 percent are not uncommon. Deformation, as manifest by the intensity of recrystallization and foliation, is heterogeneously distributed in this zone but all three plutonic units are deformed. The two youngest plutonic units (7 and 8) are massive and undeformed outside these zones and are interpreted to be posttectonic suggesting that at least one component of this shearing postdates the major regional deformation. The three plutonic units also display a more intimate intrusive relationsip than is typical outside this zone where larger areas underlain predominantly or exclusively by a single unit can be identified.

The distribution of inclusions in a northeastward trending zone extending from the volcanic promontory north of Kirby Lake strongly suggests that this zone represents a highly disrupted continuation of the greenstone belt. The predominance of amphibolitic inclusions is consistent with the basaltic character of the volcanic sequence in the greenstone belt promontory. The coincidence of shearing with the migmatitic zone may indicate that late shearing was concentrated along the greenstone belt-granitic complex contact and "deflected" into the granitic complex by the volcanic promontory. The geometry of the volcanic-promontory and inclusion zone suggests a dextral shear component. Heterogeneous deformation may have generated localized low pressure areas that attracted the emplacement of a wide variety of late plutonic rocks in this zone.

The recognition of such zones is significant on two counts. Firstly, this suggests that if such zones can be followed within granitic complexes it may be possible to demonstrate the continuity of volcanic belts across granitic complexes and permit correlation between greenstone belts. Secondly, the economic potential of such disrupted greenstone belts is largely untested and the mineral potential of "granitic" complexes may be greater than hitherto recognized.

MIDDLE TO LATE PRECAMBRIAN INTRUSIVE ROCKS (9)

DIABASE DIKES

North to northwestward trending, vertical diabase dikes, presumed to be of Middle to Late Precambrian age based upon their unmetamorphosed character, intrude all of the older rocks within the map area. These rocks are comparatively resistant to erosion and many of the wider dikes form prominent topographic highs. The dikes tend to be at a high angle to layering in the supracrustal rocks and it is probable that many smaller dikes were not located during mapping because of traverse direction and spacing.

Two varieties of diabase are distinguished on the basis of the presence or absence of plagioclase phenocrysts. The matrix of the plagioclase-phyric variety, the less common of the two types, is similar to the equigranular variety.

The width of the dikes ranges from less than 10 cm to 60 m. The narrow dikes (<1 m) typically are fine grained to aphanitic whereas the thicker dikes have a medium-grained interior and a narrow, fine-grained to aphanitic, chilled margin. Prominent joints are commonly oriented perpendicular to the contact and filled with secondary epidote. In some outcrops, a radial and/or concentric joint pattern is observed and, in one outcrop, this was observed to correspond to the termination of a dike. The joints are interpreted to originate during cooling of the dike. Equigranular dikes display a clear preferred orientation and all but one dike for which it was possible to determine a trend, have a strike between 340° and 010°. Two porphyritic diabase dikes have a trend of approximately 300° (Figure 15).

These rocks typically are massive and compositionally homogeneous. They have a rusty brown weathered surface and a grey to black fresh surface. A good diabasic texture is common with fresh to partially pseudomorphed augite interstitial to subhedral, waxy green plagioclase laths.

The diabasic texture is even more apparent in thin section. Plagioclase (labradorite) is the most abundant mineral (Table 11) and occurs as laths with interstitial augite. An opaque phase that rarely shows a skeletal crystal form is the only other abundant major mineral phase. Both olivine and quartz-bearing varieties are present but neither mineral is abundant and these types were not distinguished in the field. Apatite in trace amounts is the only other primary mineral recognized.

The plagioclase, augite, and olivine have all been affected, to greater or lesser degree, by secondary hydration reactions. The plagioclase of the equigranular varieties and the matrix of the porphyritic variety display weak to moderately intense alteration to sericite and epidote. The plagioclase phenocrysts of the porphyritic variety are intensely altered. The augite underwent a sequential retrograde alteration series as follows; augite altered to a green, fibrous amphibole (uralite), amphibole altered to biotite, and biotite altered to chlorite. The first two stages of alteration can be observed in a single, partially pseudomorphed pyroxene crystal. Olivine is altered to iddingsite or serpentine with finely disseminated magnetite.

The phenocrysts of the porphyritic variety have a waxy green colour on fresh surface and are largely replaced by sericite and epidote. The phenocrysts have some good crystal faces but most surfaces are rounded or embayed suggesting that they may have been out of equilibrium with the melt during the last stages of crystallization. The intense alteration prohibits a reliable estimate of the composition. Narrow, discontinuous, strongly zoned, unaltered rims are present on some phenocrysts.

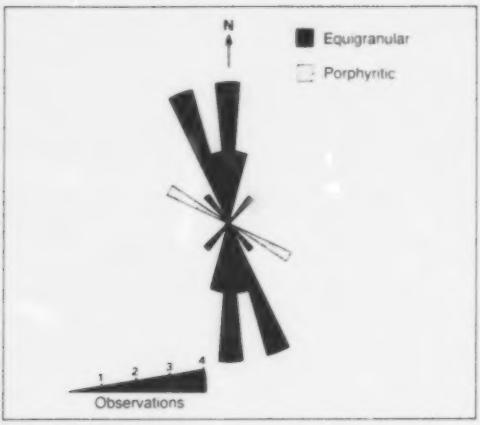

Figure 15. *Rose diagram illustrating the orientation of near vertical diabase dikes in the Grenville Lake area.*

TABLE 11. MODAL ANALYSES OF DIABASE DIKES FROM THE GRENVILLE LAKE AREA BASED ON 1000 COUNTS PER THIN SECTION.

Mineral	Sample GPB-82-64*	Sample GPB-82-211**	Sample GPB-82-259
Plagioclase	49.0	58.4	50.5
Augite	34.4	32.4	32.8
Fibrous amphibole	9.4	1.6	8.8
Biotite	1.0	-	1.6
Opaque mineral	5.6	5.6	5.4
Olivine	-	1.8	-
Quartz	0.6	-	0.8
Apatite	trace	trace	trace
Iddingsite	-	0.2	-
Serpentine	-	trace	-
Chlorite	-	-	0.1

Notes
*Sample GPB-82-64 is porphyritic and the reported modal abundances are for the matrix only. Based on visual estimate in outcrop approximately 5 to 10 volume percent of the rock is composed of plagioclase phenocrysts.

**A chemical analysis of this sample is presented in Table 12.

PHANEROZOIC

CENOZOIC

Quaternary

Pleistocene and Recent

The map area was glaciated during the Pleistocene Epoch. The direction of ice movement is interpreted to be from the northeast to the southwest on the basis of orientation of glacial striations on bedrock surface, drumlins, and drumlinoid ridges. This is consistent with the regional pattern deduced by S.C. Zoltai (1967). The scouring action of the ice exposed fresh bedrock and weathering effects today are generally limited to discoloration of the outer few millimeters of rock. The large conglomerate outcrop in the southeast corner of Kirby Township is a *roche*

TABLE 12. CHEMICAL ANALYSIS OF A DIABASE SAMPLE FROM DIKE ON GULCH RESOURCES PROPERTY IN THE GRENVILLE LAKE AREA (SEE FIGURE 4). MAJOR ELEMENTS ARE IN WEIGHT PERCENT OF THE OXIDE. TRACE ELEMENTS ARE IN PPM EXCEPT WHERE NOTED PPB.

Analysis Number	39
Field Number	GPB-82-211
SiO_2	48.80
TiO_2	1.48
Al_2O_3	14.20
Fe_2O_3	4.55
FeO	9.86
MnO	6.04
CaO	9.87
Na_2O	2.08
K_2O	0.60
P_2O_5	0.13
CO_2	0.05
S	0.03
H_2O^+	0.91
H_2O^-	0.05
Total	98.84
Rb	20
Sr	14
Li	10
Ba	180
Ce	55
Nd	45
Y	24
Co	49
Cr	86
Cu	195
Ni	80
Pb	<10
V	310
Zn	129
Ag	<1
As	10
Au(ppb)	8

moutonee with a gently sloping northeast side and a steep to vertical southwest side.

The nature of the glacial deposits in the area have been discussed by Zoltai (1967) and Gartner (1979). All of the glacial deposits are unconsolidated and represent deposition in both glaciofluvial and morainal environments. The glaciofluvial deposits (outwash plain and esker) are most extensive in southeastern Kirby Township and southern and eastern Fulford Township. Morainal deposits are less abundant but are widespread, especially in western Kirby Township and central Fulford Township. The glaciofluvial deposits consist of sand to gravel size fragments, most of which appear to have been derived from the Early Precambrian crystalline basement although not necessarily locally. Sedimentary structures (crossbedding, scour, ripple-marks) are common and well preserved in these deposits. The eskers are generally less than 10 m high but locally, as along the eskers between Aeroplane and Papineau Lakes, they are up to 20 m higher than the surrounding terrain. The morainal deposits are highly varied in the size of fragments and composition. In general, these deposits are composed of poorly

sorted detritus ranging in size from clay to very large boulders. The larger fragments are all of Early Precambrian crystalline basement and many appear to be locally derived as for example in northwestern McQuesten Township. Here, most of the rock fragments, which range in size up to boulders 4 m in diameter, are megascopically identical to the megacrystic granodioritic phase that characterizes the underlying Papineau Lake stock and extends an unknown distance to the north of the map area.

Recent deposits are associated with lakes, rivers and swamps and consist largely of sand reworked from Pleistocene deposits. Swamp deposits are extensive only in the southeastern part of McQuesten Township.

Structure

REGIONAL SETTING

The map area is located in the northern part of the Beardmore-Geraldton metavolcanic-metasedimentary belt. This belt is located in the southern part of the Wabigoon Subprovince adjacent to the Quetico Subprovince. Two characteristics that distinguish the Beardmore-Geraldton belt from other Wabigoon Subprovince "greenstone" belts are the approximately equal abundance of metavolcanics and metasediments and their pattern of occurrence in alternating, linear, east-west trending bands (Pye *et al.* 1966). This pattern is also evident on a smaller scale in the Grenville Lake map area.

MINOR STRUCTURES

All of the metasediments and metavolcanics in the map area possess a penetrative foliation. This foliation is generally parallel to the regional trend of the metavolcanic and metasedimentary units and, in most outcrops, is very nearly parallel to bedding. The foliation is defined by the planar alignment of platy and acicular minerals such as chlorite, biotite, sericite, hornblende, and actinolite. Strain, as manifest by the flattening of pillows and clasts, is heterogeneously distributed but is generally more intense closer to the contact with the Onaman-Twin Lake batholith. The plane of flattening is parallel to the foliation. The presence of two foliations can be recognized in the hinge zones of minor folds in a structurally complex area north of Kirby Lake (Figure 16; see discussion below) but could not be generally distinguished.

All of the pretectonic to syntectonic felsic intrusive phases (6) and a small proportion of the late to posttectonic megacrystic (7) and equigranular (8) phases are foliated. This foliation is defined principally by the planar alignment of biotite flakes but some of the quartz and plagioclase in the early phases are intensely flattened parallel to the biotite foliation. In most areas where the later phases (map units 7 and 8) are observed in contact with the pretectonic to syntectonic phases (6), they are massive and non-foliated and postdate the foliation in the latter. On this basis the late felsic intrusive phases are interpreted to postdate the main regional deformation. These rocks are foliated locally, as for example in the migmatite zone trending northeastward from the Kirby Lake structure and along the southeast contact of the Papineau Lake stock.

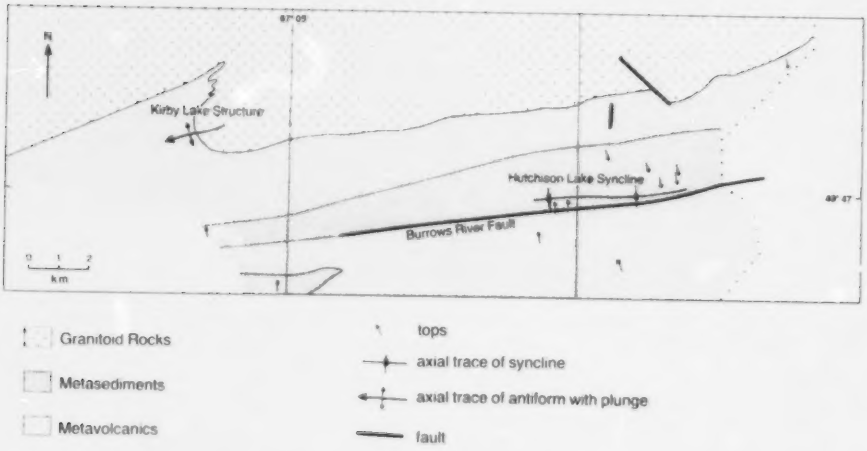

Figure 16. *Generalized geological map illustrating the major structural features recognized in the Grenville Lake area.*

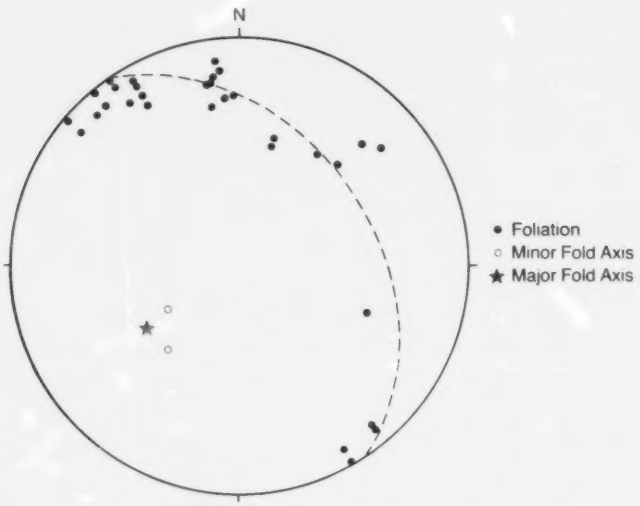

Figure 17. *Stereonet (lower hemisphere) illustrating the orientation of foliations and fold-axes in the Kirby Lake structure. The major fold-axis was determined by visually fitting a great circle to the poles to foliation.*

Few lineations were recorded during the course of field work, in part due to the limited local relief on most outcrops of the metavolcanics and metasediments. Lineations measured include minor fold-axes and mineral lineations.

MAJOR FOLD STRUCTURES

KIRBY LAKE STRUCTURE

The promontory of mafic metavolcanics into the Onaman-Twin Lakes batholith in Kirby Township is one of the most structurally complex parts of the map area. In this area, informally referred to as the Kirby Lake structure, the Kirby Lake metavolcanics and adjacent pretectonic to syntectonic felsic plutonic rocks are deformed into a broad regional fold.

A stereonet plot of the poles to foliation surfaces (Figure 17) suggests a southwestward plunging structure. Two minor folds from this area have a similar plunge and are interpreted to be parasitic minor folds. Within these minor folds, an early foliation with concordant tonalite veins is tightly folded with the attendant development of a second foliation parallel to the axial plane of the minor fold (Photo 12). These two foliations are difficult to distinguish outside the hinge areas of the minor folds.

Further evidence for the presence of two foliations is in the felsic plutonic rocks. The main regional foliation that is present in the pretectonic to syntectonic plutonic rocks predates the emplacement of the two youngest felsic plutonic units. These younger rocks are foliated in the inclusion-rich zone trending northeastward from the Kirby Lake structure implying that a period of pluton emplacement separated the development of a main regional foliation from the latest development of foliation.

These observations suggest that the north limb of the fold has been modified by a deformation that postdates the initial development of the Kirby Lake structure. This deformation most probably represents a late dextral shear localized near the granite-greenstone contact. The presence of an irregularity in the contact and a lithologically heterogeneous zone in the granite extending off the end of this irregularity caused this late shear to be deflected into the Onaman-Twin Lake batholith and resulted in the local deformation of the latest intrusive phases.

Photo 12. *Detail of folding of an earlier foliation with concordant tonalite veining with attendant development of a second foliation parallel to the axial plane of the fold. Approximately 1 km southwest of North Kirby Lake.*

HUTCHISON LAKE SYNCLINE

The only area from which reliable tops indicators are sufficiently abundant to permit delineation of major fold structures is the eastern part of the Hutchison Lake metasedimentary unit. Tops are consistently in the same direction as the dip of the beds (no overturning). The data suggest the presence of a regional synclinal structure although local reversals due to minor folding are present. Although there is insufficient outcrop to precisely define its location, the axial trace of this fold is asymmetrically disposed towards the southern margin of the Hutchison Lake metasediments and may even be truncated by the contact between the Hutchison Lake metasediments and Dionne Lake metavolcanics in the vicinity of Hutal Lake.

FAULTS

In this area of extensive Pleistocene deposits, faults are difficult to recognize. Small-scale faulting with displacements of up to 1 m are common and no systematic regional pattern to orientation or sense of displacement was noted.

A major fault, referred to as the Burrows River Fault, is inferred to separate the Hutchison Lake metasediments from the Dionne Lake metavolcanics. The evidence for this fault includes the following.

1. The south limb of the Hutchison Lake syncline is much thinner than the north limb. The presence of a fault is one way to explain the "missing" stratigraphy.
2. In contrast to their well-preserved nature elsewhere, outcrops on the south shore of Hutchison Lake have zones of relatively undeformed metasediments alternating with intensely sheared and kink banded schist.
3. A topographic lineament, most obviously manifest by the orientation of the Burrows River in eastern McQuesten Township and central Fulford Township, is coincident with the inferred fault. This lineament may be fortuitous in Fulford Township where, for part of its length, the river parallels an esker although bedrock valley control of esker development has been noted in the Larder

Lake area (Cam Baker, Geologist, Ontario Geological Survey, Toronto, personal communication, 1983).

4. Two distinctly different lithologic assemblages are in juxtaposition across the inferred fault.

Any one or two of these lines of evidence would not in themselves be diagnostic but the coincidence of all four strongly suggests that the contact between the Hutchison Lake metasediments and Dionne Lake metavolcanics is a fault. The amount and sense of displacement on this fault is unknown. There is little outcrop in the vicinity of the northern contact of the Hutchison Lake metasediments with the Kirby Lake metavolcanics and the possibility of the existence of a fault here could not be evaluated.

Two faults at a high angle to bedding are recognized in western McQuesten Township and are responsible for minor offset of lithologic contacts. Southwest of McQuesten Lake, a northwestward trending fault has resulted in the right-lateral displacement of the greenstone-granite contact of approximately 100 m. A Proterozoic diabase dike was emplaced into the northward trending fault (south of the east end of Papineau Lake) subsequent to the dislocation.

IMPLICATIONS FOR REGIONAL STRUCTURAL AND STRATIGRAPHIC SYNTHESIS

The recognition of a fault of unknown displacement at the contact between a metasedimentary unit (Hutchison Lake metasediments) and metavolcanic unit (Dionne Lake metavolcanics) has important implications for regional stratigraphic synthesis. Similar faults have been postulated elsewhere in the Beardmore-Geraldton belt (Mackasey 1970a,b, 1975, 1976; Mackasey *et al.* 1976a,b). Pye *et al.* (1966) summarized this and other data and indicated numerous faults and lineaments parallel to regional strike. These faults occur both at the contact of, or entirely within either of, the metasedimentary or metavolcanic units. In a few cases, the contact faults or a subsidiary splay of the faults appear to deflect into either the metavolcanic or metasedimentary units. In view of the inherent difficulty in recognizing strike-faults, it is suggested here that it is probable that the linear bands of metvolcanics and metasediments are largely fault bounded and stratigraphic correlations between fault-bounded domains are uncertain.

The displacement on these faults is unknown but the consistent juxtaposition of such different types of supracrustal sequences suggests these faults may represent major dislocations. Locally, as for example in Legault Township (Mackasey *et al.* 1976a), Proterozoic diabase dikes are apparently offset by these faults and in some faults the offset does not appear to be large. This suggests that very late movement occurred on these faults but it is most likely that this represents reactivation of pre-existing faults and that the initial formation of these faults and the juxtaposition of metavolcanic and metasedimentary units took place during the Early Precambrian.

The presence of alternating, tectonic slices of metasediments and metavolcanics is especially interesting when viewed from a regional perspective. The Beardmore-Geraldton belt is located at the interface between a greenstone-tonalite subprovince (Wabigoon) and paragneiss subprovince (Quetico). L.D. Ayres (1969) suggested that the Quetico Subprovince represents a sedimentary basin that developed synchronously with adjacent volcanic arcs. The approximately equal abundance of metavolcanics and metasediments in the Beardmore-Geraldton belt is typical of neither greenstone nor paragneiss terrains. In a plausible, though at this stage rather speculative, paleotectonic reconstruction the Beardmore-Geraldton belt may represent the interface between an Early Precambrian volcanic arc (Wabigoon) and sedimentary basin (Quetico). The distinctive linear form and lithologic proportions of this belt are a consequence of the tectonic interleaving of marginal parts of these volcanic and sedimentary terrains.

Economic Geology

HISTORY OF EXPLORATION

The information on exploration activity reported here is taken from the Resident Geologist's Files, Ontario Ministry of Northern Development and Mines, Thunder Bay, and Macdonald (1943). Numbers in parentheses following company or property names indicate property location on the map in the back pocket.

The main focus for exploration activity in the map area has been gold mineralization. A major period of exploration activity followed the discovery, in 1932, of gold mineralization on Kenogamisis Lake, approximately 5 km south of the map area. This led to the discovery of auriferous quartz veins approximately 600 m south of the west end of Hutchison Lake. This property was successively owned by Hutchison Lake Gold Mines Limited (1935 to 1946), Maylac Gold Mines Limited (1946 to 1958), and Gulch Resources Limited (15) (1958 to present). Development work was carried out on four levels. Production during the years 1946 and 1947 totalled 792 ounces of gold and 46 ounces of silver at an average grade of 0.52 ounce per ton gold and 0.03 ounce per ton silver (Assessment Files in Resident Geologist's Files, Ontario Ministry of Northern Development and Mines, Thunder Bay). Macdonald (1943, p.16) reported that the gold occurs in narrow quartz veins and associated sulphide mineralization within "sheared and carbonatized tuffs." Limited exploration was carried out on adjacent properties during the period 1935 to 1940.

Comparatively little mineral exploration was carried out in the area from 1940 to 1960. The limited exploration carried out since 1960 has focused on ground geophysical and diamond drilling follow-up of airborne geophysical survey anomalies.

In 1961, Kateri Mining Company Limited (18) optioned a property near Kirby Lake on which they reported the occurrence of two mineralized shear zones. They subsequently flew an airborne electromagnetic survey over much of Fulford and Kirby Townships that identified several other anomalous zones. Most of these zones occur in the vicinity of either a persistent chert-magnetite ironstone in the Kirby Lake volcanic unit (see below) or near the contact of the Dionne Lake volcanic unit and the Hutchison Lake sedimentary unit. They reported traces of gold in pyritic zones of ironstone to the west of Kirby Lake and recommended follow-up work. Ground electromagnetic surveys of other groups was discouraging and no further work was carried out.

In 1965, Roy Barker (3) drilled nine diamond-drill holes in the northeastern part of McQuesten Township. Most of these drillholes encountered mafic metavolcanics and ironstone with subeconomic zinc and copper mineralization. In the same year The Algoma Steel Corporation Limited (1) carried out diamond drilling on a magnetically anomalous zone in the central part of McQuesten Township. This drilling encountered interlayered magnetite and clastic sedimentary rocks.

From 1969 to 1971, Canadian Nickel Company Limited (5-10) carried out diamond drilling in several widely scattered parts of the map area. Subeconomic sulphide mineralization is reported to be associated with ironstone in the vicinity of Kirby Lake, north of Grenville Lake, north of Hutchison Lake, in northeastern McQuesten Township, and east of Dionne Lake.

In 1972, Hudson Bay Exploration and Development Company Limited (16,17) carried out work on two separate areas in north-central and northeastern McQuesten Township. Both of these areas lie near a laterally persistent ironstone (discussed below). Surface geophysics located airborne electromagnetic anomalies and diamond drilling encountered massive and disseminated sulphide minerals and sulphide-bearing graphitic zones from which subeconomic zinc-copper mineralization is reported over narrow widths.

BASE METAL MINERALIZATION

No significant deposits of base metal mineralization are known to occur in the map area. There are, however, numerous occurrences of barren or subeconomic, massive and stringer sulphide mineralization and there is potential for significant

deposits to be found. Sulphide mineralization is discussed separately for the three principal associations in which it occurs.

DEPOSITS ASSOCIATED WITH THE IRONSTONE HORIZON IN THE KIRBY LAKE METAVOLCANICS

Numerous barren or subeconomic sulphide mineral occurrences are spatially associated with the ironstone horizon in the Kirby Lake metavolcanics (Table 13). Most of the mineralization is hosted by the ironstone or chert but some mineralization also occurs in graphitic schist within the adjacent mafic metavolcanics. Very minor amounts of felsic metavolanics and quartz-feldspar porphyry are near the mineralized zones, particularly in the eastern part of the map area, but the mineralization is not obviously related to them. The sulphide minerals occur as massive, stringer, and disseminated deposits.

Pyrite and pyrrhotite are the predominant sulphide minerals within these occurrences. Chalcopyrite, sphalerite, galena, and arsenopyrite are reported locally. Zn is the predominant base metal throughout the ironstone horizon. Pb, in the form of galena, is only recognized in the westernmost occurrence whereas Cu (chalcopyrite) is relatively more abundant in the eastern part of this horizon. No gold is reported to be associated with this horizon and analyses of grab and chip samples across sulphide-rich zones carried out by the present survey confirmed that no gold is present at the ppm level. Silver is associated with the Pb-Zn mineralization from the western part of this horizon

DEPOSITS ASSOCIATED WITH FELSIC METAVOLCANICS AND IRONSTONE

The only occurrence of this association in the map area occurs at the eastern end of Dionne Lake. Rock outcrops are scarce in this area and the geological relationships are inferred from outcrops examined to the east and north of the occurrence, aeromagnetic interpretation, and the log of a single diamond-drill hole (Canadian Nickel Company Limited - Dionne Lake [1971], Property Number 8). The diamond-drill hole intersected 50 m of chert-magnetite ironstone with numerous sulphide-rich zones. The only sulphide minerals reported are pyrrhotite and pyrite.

An outcrop of a coarse felsic pyroclastic breccia with a carbonatized matrix is located approximately 1 km east of the drillhole on Highway 584. Minor sulphide mineralization in this rock (pyrrhotite with minor pyrite) both predates and post-dates brecciation with sulphide minerals occurring as stringers in both fragments and matrix. This rock is similar to that described as "mill-rock" (Sangster 1972). If the inferred contacts and stratigraphic tops (based on a few pillow tops in the mafic metavolcanics) are correct, this showing resembles a classical volcanogenic deposit with sulphide minerals associated with ironstone overlying a coarse, felsic pyroclastic breccia with stringer sulphide mineralization and carbonatization.

DEPOSITS ASSOCIATED WITH VEINS AND SHEARED ZONES

This type of mineralization is widespread but is probably of little significance for economic base metal sulphide mineralization. Numerous quartz and/or carbonate veins have minor sulphide minerals (predominantly pyrite) either within the veins or in the adjacent host rocks. Samples of this type of mineralization collected by the present survey for analysis ran only minor amounts of Cu, Zn, Pb, and Ni. The foremost example of this type of mineralization examined by the present survey is the Dubrex Group (11) occurrence. Two types of sulphide mineralization are present here including a stringer sulphide (pyrrhotite) zone in sheared mafic metavolcanics containing later quartz-carbonate-pyrite veins characterized by the presence of euhedral pyrite cubes.

GOLD

Virtually all of the gold mineralization reported from the map area is associated with veins. By far the most significant gold mineralization found so far is that on the Gulch Resources Limited (15) property which in the past has produced

TABLE 13. SUMMARY OF DEPOSITS IN THE GRENVILLE LAKE AREA ASSOCIATED WITH THE LATERALLY PERSISTENT IRONSTONE HORIZON IN THE KIRBY LAKE METAVOLCANICS BASED ON WORK FILED FOR ASSESSMENT CREDIT, AEROMAGNETIC INTERPRETATION, AND EXAMINATION OF SURFACE OUTCROPS. THE OCCURRENCES ARE LISTED IN ORDER OF THEIR GEOGRAPHICAL POSITION FROM WEST TO EAST.

Occurrence*	Associated Lithologies	Sulphides**	Comments
Canadian Nickel Co. Ltd. - Kirby Lake [1969] (5)	mafic metavolcanics, chert, banded ironstone	py, sp, gn, cp in ironstone, chert and shear zones	analysis of sample collected by present survey ran 0.26% Pb, 0.32% Zn, 0.52 oz/ton Ag, trace Au, Cu over 1 m
Kateri Mining Co. Ltd. [1961] (18)			
Oster, Joseph (25)			
Canadian Nickel Co. Ltd. - Grenville Lake [1971] (7)	mafic metavolcanics, ironstone	po, py, and cp	no outcrop-geology inferred from drill logs and aeromagnetic maps
Canadian Nickel Co. Ltd. - Hutchison Lake [1971] (9)	mafic metavolcanics, gabbro, felsic metavolcanics, ironstone	py and po	No assays reported
Lakehead Gold Mines Ltd. (20)	mafic metavolcanics, banded ironstone		no details available
Universal Exploration (1937) Ltd. [1939] (27)			
Barker, Roy [1965] (3)	mafic metavolcanics, quartz porphyry	py and po in ironstone	best analyses are 0.12% Zn and 0.06% Cu over narrow widths

TABLE 13 cont'd.

Occurrence*	Associated Lithologies	Sulphides**	Comments
Hudson Bay Exploration and Development Co. Ltd.-Group E [1972] (16)	mafic metavolcanics, rhyolite, quartz-feldspar porphyry, banded ironstone	po and py in ironstone and graphitic schist	located south of main ironstone horizon - best analyses run 0.2% Zn, 0.1% Cu, traces of Au and Ag over narrow widths
Hudson Bay Exploration and Development Co. Ltd. -Group M [1972] (17)	mafic metavolcanics, quartz-feldspar porphyry, ironstone	massive and stringer po, py, cp and asp in metavolcanics	best analyses run 0.5% Zn, 0.1% Cu and traces of Au and Ag over narrow widths
Canadian Nickel Co. Ltd.-Northeast McQuesten Township [1971] (17)	mafic metavolcanics, ironstone, graphitic schist	po, py, cp	

Notes:
*Some contiguous or overlapping occurrences are grouped together
**predominant sulphides are underlined

Abbreviations

py - pyrite

po - pyrrhotite

cp - chalcopyrite

gn - galena

sp - sphalerite

asp - arsenopyrite

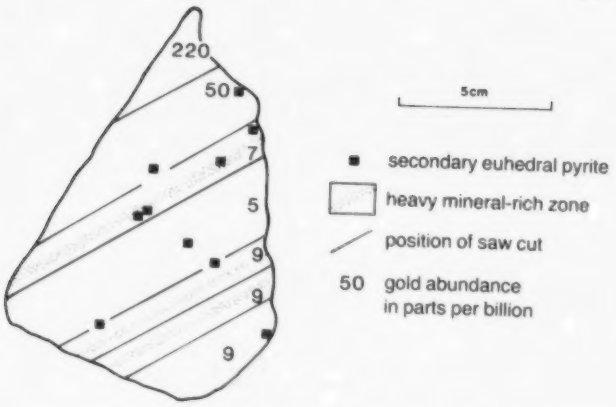

Figure 18. *Sketch of sample GPB-82-128G illustrating the position of saw cuts in relation to concentrations of heavy minerals and geochemical results (analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto).*

approximately 800 ounces of Au and 50 ounces of Ag. Most of the other occurrences from which gold values have been reported are from similar rocks along strike to the east or west.

The following points may be relevant to the localization of gold in this part of the map area.

1. The host rocks are mafic metavolcanics of the Dionne Lake metavolcanic unit.
2. The mafic metavolcanics in this area are relatively more intensely altered than those away from this area. This alteration may be associated with the veining.
3. The veins occur principally in, and parallel to, sheared zones in the mafic metavolcanics. These sheared zones are parallel to bedding, the regional structural trend, and the Burrows River Fault which is inferred to pass approximately 600 m north of the shaft on the Gulch Resources Limited property.
4. The mineralization is associated with quartz (± carbonate) veins and particularly with the accessory sulphide minerals that occur within the veins and associated with these veins in the adjacent wall rock.

Quartz veins are found throughout the map area and many of those greater than 10 cm wide located by the present survey showed evidence of having been prospected but no gold occurrences are reported in the assessment files. Samples from several of these veins collected by the present survey for conventional assay all contained only traces of gold.

PALEOPLACER GOLD

Geochemically anomalous gold (195 ppb) was identified in a single sample of sandstone associated with conglomerate in the Volcan Lake metasediments (see Table 6, sample 128G). This sample contains thin laminations relatively enriched in heavy minerals, suggesting the possibility that this gold anomaly may be due to concentration of detrital gold in the sedimentary environment. Further analyses (Figure 18) confirmed the existence of a geochemical anomaly in parts of the sample but this could not be clearly related to recognizable heavy mineral concentrations. Although these metasediments are not as sedimentologically mature as most placer gold environments, the possibility of concentrations of gold in paleoplacer deposits in the conglomeratic association in the metasediments of the Beardmore-Geraldton belt deserves further study.

SILVER

A minor amount of Ag is associated with Au mineralization in the Dionne Lake metavolcanics. There are three known locations where Ag occurs greatly in excess of Au.

1. Ag (0.52 ounce/ton) (Geoscience Laboratories, Ontario Geological Survey, Toronto) is associated with Pb and Zn mineralization in a chert horizon on the Joseph Oster (25) property at Kirby Lake
2. A narrow vein is reported (Resident Geologist's Files, Ontario Ministry of Northern Development and Mines, Thunder Bay) on the J. Pichette (26) occurrence where Ag (0.76 ounce/ton) and Au (0.06 ounce/ton) are associated with Zn in quartz veins
3. A grab sample collected for analysis by the present survey from a quartz-veined, iron-stained, altered, mafic metavolcanic ran 0.22 ounce/ton Ag and only trace Au and base metals (Geoscience Laboratories, Ontario Geological Survey, Toronto). The outcrop from which this sample was collected is located 200 m southwest of the south end of Hutal Lake.

IRON

Two major ironstone units are present in the map area. One of these, the magnetite layers in the Hutchison Lake metasediments, has been investigated for its iron potential (The Algoma Steel Corporation Limited, property number 1) but the claims were allowed to lapse. The chert-magnetite banded ironstone in the Kirby Lake metavolcanics is probably not thick enough to be commercially viable in the foreseeable future. Both ironstones have minor amounts of sulphide mineralization associated with them.

MOLYBDENUM

No significant Mo occurrences are known in the map area. The present survey detected minor disseminated molybdenite in an outcrop of weakly foliated, megacrystic granite on the south shore of North Kirby Lake in northeast Kirby Township. Macdonald (1943) reported the occurrence of Mo mineralization in the Onaman-Twin Lakes batholith approximately 10 km north of the map area. There is potential for mineralization of this type in the granitoid rocks of the map area.

RECOMMENDATIONS FOR FUTURE MINERAL EXPLORATION

The northern half of the Beardmore-Geraldton belt (including Kirby, Fulford, and McQuesten Townships) has not received the attention afforded the southern half of this belt where most of the gold production occurred. This, in part, reflects the poor exposure in the north that discourages prospecting. The area has considerable potential for both gold and base metal mineralization. Of particular interest to the small mining company and prospector is the ready accessibility of the area and the availability, within one hours drive, of a custom milling facility (GOMILL) at Beardmore. The availability of this latter facility could permit small-scale development of high-grade, low-tonnage gold deposits.

The most favourable area for gold mineralization is the zone of highly altered mafic volcanic rocks occurring in the Dionne Lake metavolcanic belt. The only past-producing gold mine in the area occurs along the northern contact of this zone, and the small, but high-grade nature of the ore here suggests that further work in the area is warranted.

Many of the sulphide mineral showings and conductive zones identified to date in the area occur in association with iron formation in the Kirby Lake metavolcanic belt. Although no economic mineralization has been recognized, subeconomic zinc and/or copper mineralization with traces of silver has been recognized at Kirby Lake, north of Grenville Lake, and in northeastern McQuesten Township. The lateral persistence of this mineralization suggests that this may represent a favourable horizon for future exploration.

The felsic metavolcanics of the Dionne Lake metavolcanic belt are poorly exposed and may be more extensive than illustrated. At least one of these units is spatially associated with a magnetically anomalous zone where diamond drilling has intersected a 50 m wide chert-magnetite ironstone with abundant sulphide-rich (mostly pyrite and pyrrhotite) zones. The potential for economic sulphide mineralization of this type should be further tested.

DESCRIPTION OF PROPERTIES

Information on properties and showings presented here is taken from the files of the Resident Geologist's Office, Ontario Ministry of Northern Development and Mines, Thunder Bay, Assessment Files Research Office, Ontario Geological Survey, Toronto, Annual Reports of the Ontario Department of Mines, Macdonald (1943), and successive issues of the Canadian Mines Handbook. The numbers in parenthesis following each property description heading refers to property location number on the map (back pocket), and to those described in the text.

THE ALGOMA STEEL CORPORATION LIMITED [1965] (1)

In 1965, The Algoma Steel Corporation Limited held 46 contiguous mining claims in central McQuesten Township. The claim block coincides with a prominent aeromagnetic anomaly (Ontario Division of Mines-Geological Survey of Canada 1974a,b). The area is underlain by thin to medium bedded wacke with interlayered magnetite layers. Two diamond-drill holes, both situated on claim TB 113169 near the geographical centre of McQuesten Township, encountered alternating wacke and magnetite with minor quartz veining and disseminated sulphide minerals. The claims were subsequently allowed to lapse.

ROY BARKER - SOUTHWEST McQUESTEN TOWNSHIP PROPERTY (2)

In 1957, Roy Barker held five contiguous patented claims (TB82969, 82947 to 82950, inclusive) in the extreme southwestern part of McQuesten Township and the southeastern part of Fulford Township. No outcrop occurs on these claims. A single diamond-drill hole encountered "diorite" and "greywacke" with minor quartz-carbonate veining and disseminated pyrite. No economic mineralization is reported. These claims are still in good standing but ownership has reverted to the Crown.

ROY BARKER [1965] (3)

In 1965, Roy Barker held 61 contiguous claims (TB108608 to 108609, 108777 to 108780, 108928 to 108929, 114207 to 114211, 115557 to 115558, 116303 to 116325 and 116506 to 116509, inclusive). In the eastern part of this claim block an area near an unnamed lake situated 3.6 km east of the island in McQuesten Lake was tested by eight of nine diamond-drill holes. Adjacent and partially overlapping areas were subsequently held and investigated by Hudson Bay Exploration and Development Company Limited (17) and Canadian Nickel Company Limited (10).

Diamond drilling in the eastern part of this claim block encountered amphibolitic mafic metavolcanics (with silicified zones and quartz-carbonate stringers), quartz porphyry, and banded ironstone. Magnetite-chert ironstone, with or without a major sulphide mineral component, is abundant and occurs in zones up to 18 m thick although most units are less than 1 m. Subeconomic Zn (<0.12 percent) and Cu (<0.06 percent) mineralization occurs over narrow widths in association with sulphide-rich (predominantly pyrite and pyrrhotite) zones in the ironstone. Assay results (Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay) suggest there is no gold associated with the zones analyzed.

A single drillhole near Highway 584 in the western end of this claim block encountered similar interlayering of amphibolitic, mafic metavolcanics and banded ironstone. Disseminated to massive pyrrhotite and pyrite occur in a 9 m intersection of ironstone but no economic mineralization is reported. The rocks here are along strike with those investigated in the eastern part of the claim block. The sulphide

mineralization in both areas is spatially related with ironstone that can be discontinuously traced by means of surface outcrops, diamond drill records and aeromagnetic maps (Ontario Division of Mines-Geological Survey of Canada 1974a,b,c,d) from northeastern McQuesten Township to west-central Kirby Township.

ROY BARKER AND W. DAWIDOWICH [1953] (4)

In 1953, Roy Barker and William Dawidowich held four contiguous claims (TB44646 to 44649, inclusive) in central McQuesten Township. The area is underlain by thin- to medium-bedded wacke with interbeds of magnetite. Four short diamond-drill holes were collared on claim TB44646 but the precise location of the holes within the claim are not known. All of these drillholes encountered "diorite" and "banded" and "sheared" rocks. Quartz veining, quartz-carbonate stringers, and minor sulphide minerals (pyrite and pyrrhotite) are common. No economic mineralization is reported and the claims were allowed to lapse.

CANADIAN NICKEL COMPANY LIMITED

The Canadian Nickel Company Limited undertook diamond drilling in a number of widely scattered locations in Kirby, Fulford, and McQuesten Townships. There is no record of the basis for drill site selection but inasmuch as some of the areas investigated have no exposure, it is probable that an airborne geophysical survey was carried out. The results of this drilling are summarized below (properties 5 to 10).

Kirby Lake [1969] (5)

The Canadian Nickel Company Limited, in 1969, held 28 contiguous claims (TB221410 to 221413, 221425 to 2211435 and 287922 to 287934, inclusive) in the vicinity of Kirby Lake. The area partially overlaps an area investigated earlier by Kateri Mines Limited (18) and the Joseph Oster (25) property.

The main area of interest was evidently north and east of the north bay of Kirby Lake. This area is underlain by massive and pillowed mafic flows with subordinate interlayered chert-magnetite ironstone. Two diamond-drill holes were both collared approximately 300 m north of an aeromagnetic anomaly interpreted to correspond to a major ironstone horizon that can be traced discontinuously across the entire area. The two drillholes are approximately 800 m apart along strike and both intersected mafic metavolcanics with subordinate interlayered ironstone. Only minor disseminated sulphide minerals are reported and the claims were allowed to lapse.

Wildgoose Lake [1970] (6)

In 1970, Canadian Nickel Company Limited held four contiguous claims (TB278362 to 278365, inclusive) near North Bay of Wildgoose Lake. The claims adjoin the company's Kirby Lake claims to the north. There is no exposure in the area but the single diamond-drill hole lies near the inferred southern contact of the Hutchison Lake metasedimentary belt that is inferred to be a fault. The drilling encountered graphitic biotite schist (sheared metasediments?) and intermediate to mafic metavolcanics. Minor pyrite and pyrrhotite are present but no economic mineralization was noted and the claims were allowed to lapse.

Grenville Lake [1971] (7)

In 1971, Canadian Nickel Company Limited held 17 contiguous claims (TB290900 to 290916, inclusive) on, and north of, Grenville Lake. There is little outcrop in the vicinity of this claim block but the area is inferred to be underlain by mafic metavolcanics. An aeromagnetic anomaly in the northern part of their claim group suggests that a major ironstone horizon that can be traced discontinuously across the map area occurs in this part of the area. Three diamond-drill holes in the magnetically anomalous zone in the northern part of the property intersected mafic

volcanic rocks. One of these also intersected several narrow (<2 m) zones of banded chert-magnetite ironstone. Pyrrhotite and pyrite with traces of chalcopyrite are present but no significant economic mineralization was noted.

Two diamond-drill holes near Grenville Lake in the southern part of this claim group intersected mafic metavolcanics, gabbro, minor chert-magnetite ironstone, and graphitic schist. Pyrite and pyrrhotite were the only sulphide minerals identified and the claims were allowed to lapse.

Dionne Lake [1971] (8)

In 1971, Canadian Nickel Company Limited held four contiguous claims (TB276562 to 276565, inclusive) near the east end of Dionne Lake in southeastern Fulford Township. These claims adjoin the Gulch Resources Limited (15) property to the north and lie within part of that area previously held by Lac-Teck Gold Mines, Limited (19).

No outcrop occurs on these claims. A carbonatized, felsic tuff-breccia outcrop is approximately 1 km east of the claims on Highway 584 near Marie Lake. The inferred northern contact of this unit passes through the claim group and felsic metavolcanics underlie most of the claim group. The single diamond-drill hole collared on this property is situated in a weak aeromagnetic anomaly along this contact. This drilling encountered 165 feet of chert-magnetite ironstone with numerous sulphide-rich zones and, to the north of the ironstone, 410 feet of "metasedimentary" rocks that also contain abundant disseminated sulphide mineralization. Although the sulphide minerals are abundant, the zone is apparently barren with the only sulphide minerals being pyrrhotite and pyrite and the claims were allowed to lapse.

Hutchison Lake [1971] (9)

In 1971, Canadian Nickel Company Limited held 11 claims (TB276542 to 276545 and 276552 to 276558, inclusive) to the north of Hutchison Lake in Fulford and McQuesten Townships. This area is underlain by mafic flows, gabbro, fragmental felsic metavolcanics, and banded ironstone. Two diamond-drill holes in the northeastern part of this claim group intersected mafic metavolcanics with minor chert-magnetite ironstone in one of these holes. A single drillhole in the southwestern part of the claim group intersected mafic metavolcanics. Only minor pyrite and pyrrhotite with no economic sulphide mineralization are reported and the claims were allowed to lapse.

Northeast McQuesten Township [1971] (10)

In 1971, Canadian Nickel Company Limited held four contiguous claims (TB251703 to 251706, inclusive) in northeastern McQuesten Township. The area is underlain predominantly by mafic metavolcanics and lies near a laterally persistent horizon with abundant banded ironstone. A single diamond-drill hole intersected mafic metavolcanics with minor graphitic schist and massive sulphide mineralization. Sulphide minerals are predominantly pyrrhotite and pyrite with minor chalcopyrite. No economically significant mineralization was noted and the claims were allowed to lapse.

DUBREX GROUP [1940] (11)

The Dubrex group of six claims (TB18072 to 18077, inclusive) occurring northeast of the north bay of Hutchison Lake was held during the staking rush following discovery of gold on the Gulch Resources Limited (15) property (Macdonald 1943). The main showing is exposed in a pit located approximately 800 m northeast of the north end of Hutchison Lake. The main rock type exposed on the outcrop is highly sheared, massive, and possibly locally pillowed, altered mafic metavolcanics. The alteration includes epidotization and introduction of carbonate and silica. Two vertical, narrow (<40 cm) diabase dikes trending 340° cut the mafic metavolcanics.

Two types of mineralization are present in the pit on the northeast side of this outcrop. Disseminated and stringer sulphide mineral zones (pyrrhotite with subordinate pyrite) occur in highly sheared mafic metavolcanics. A second, later type of mineralization is associated with quartz veins that contain subhedral to euhedral pyrite with growth striated crystal faces. Analysis results (Geoscience Laboratories, Ontario Geological Survey, Toronto) for both types of mineralization indicate only traces of Au, Ag, Cu, Pb, Ni, and Zn.

EAST LACOMA MINES LIMITED (Hutchineau Gold Mines Limited) [1939] (12)

In 1939, East Lacoma Mines Limited acquired the assets of Hutchineau Gold Mines Limited that included nine claims (TB16344 to 16345 and 17758 to 17765, inclusive) situated south of Hutchison Lake and adjoining the Nipilac Goldfields Limited (24) property. The latter company carried out most of the exploration on the property and the former company became inactive shortly after the acquisition and the claims were allowed to lapse.

The property is underlain, in part, by fine- to medium-grained, massive and pillowed, altered mafic flows similar to those observed at the Gulch Resources Limited property. Also present are fine and coarse, fragmental, felsic metavolcanics. Macdonald (1943, p.18) reported that mineralization is associated with quartz veins.

> "The main showing, situated on claim T.B. 19,474, is a quartz vein in a sheared andesite. Quartz is present over a length of 390 feet, running N. 70°W. The vein shows considerable variation in width but gradually decreases in size towards the west end and abruptly ends at the east end with a maximum width of 8 feet. Ankerite, pyrite, chalcopyrite, and sphalerite are present in the quartz, but mineralization is uneven. No information as to gold content was obtained."

FIVE SISTERS GOLD MINES LIMITED [1937] (13)

In 1937, Five Sisters Gold Mines Limited held six claims (TB14043, 14044, 14046, 14047, 14049, and 14050) at the west end of Hutchison Lake. Much of the property is over the lake and extensive Pleistocene sand and gravel deposits occur elsewhere on the property. It is reported that surface exploration was carried out in 1936 (Northern Miner Press 1937, p.91) but the nature of this work is unknown. The property is inferred to be underlain by wacke of the Hutchison Lake metasedimentary belt. The claims were allowed to lapse.

GREENSTONE GOLD PROSPECTING AND DEVELOPMENT COMPANY LIMITED [1938] (14)

Macdonald (1943, p.18) reported:

> "The property of Greenstone Gold Prospecting and Developing Company, Limited, consists of 28 unsurveyed claims situated immediately east of Hutal lake. The rocks on the property include sediments and volcanics. The sediments are greywackes and iron formation. Several quartz veins are present in the iron formations northeast of Hutal lake. They are characteristically lenslike in nature and are slightly mineralized with pyrite and chalcopyrite. The volcanics include coarse- to fine-grained basic flows and slaty and feldspathic tuffs. The tuffs are usually markedly sheared; some of them are carbonatized.
>
> The greatest amount of work has been done on the volcanic rocks 100 chains east of the southeast corner of Hutal lake. One quartz vein in carbonatized tuff is situated 10 chains south of Burrows river. It is mineralized with ankerite, pyrite, chalcopyrite, and sphalerite. No report on gold values could be obtained".

The property apparently lies astride the Burrows River Fault that separates turbiditic wacke with interlayered magnetite on the north from massive and pillowed mafic flows and fragmental felsic metavolcanics to the south. Most of the quartz in the metasediments occurs in concordant, boudinaged quartz stringers

associated with magnetite that may represent thoroughly recrystallized chert. Other quartz veins are clearly discordant. Analyses of concordant quartz veins in the metasediments ran only traces of Au, Ag, Cu, Pb, Ni, and Zn (Geoscience Laboratories, Ontario Geological Survey, Toronto). The showing in the volcanic rocks was not located by the present survey.

The company apparently carried out surface exploration in 1937 to 1938 and planned diamond drilling but there is no indication this work was carried out. The company became inactive and the claims were allowed to lapse.

GULCH RESOURCES LIMITED (15)

The only past-producing mine in the map area is presently owned by Gulch Resources Limited. The property is located southwest of Hutchison Lake in Fulford Township and consists of 19 patented claims (TB14228, 14229, 14660 to 14663, 15088 to 15094, 15582 to 15584 and 21829 to 21831, inclusive). The previous owners of the property were Hutchison Lake Gold Mines Limited and Maylac Gold Mine Limited.

History

Gold was originally discovered on the property in September of 1934 by George and Frank Papineau. Hutchinson Lake Gold Mines Limited was incorporated in June of 1935 and acquired 19 claims covering the showing. The name of this company was subsequently changed to Hutchison Lake Gold Mines Limited. This company carried out extensive surface exploration and diamond drilling that culminated in the sinking of a shaft to a depth of 250 feet. Development work, consisting of 1558 feet of drifting and 1281 feet of crosscutting, was carried out on two levels at 125 feet and 225 feet. Development and exploration was temporarily suspended in the fall of 1938.

In 1939, Hutchison Lake Gold Mines Limited entered into a financial agreement with Howey Gold Mines, Limited, whereby the latter company took over responsibility for the drilling operations. By the end of the year, 6530 feet of diamond drilling was completed. Some high-grade intersections were reported including one of coarse free gold over 12 inches with the adjoining 19 inches running $196/ton (5.6 oz/ton) Au (Canadian Mining Journal 1939, p.448). Operations were stopped at the end of the year and the mine remained inactive for some time.

In 1946, Maylac Gold Mines Limited acquired the property from Hutchison Lake Gold Mines Limited. From 1946 to 1947, Maylac Gold Mines Limited deepened the shaft to 450 feet and established levels at 325 feet and 425 feet. Development work consisted of 169 feet of drifting and 166 feet of crosscutting on the fourth (425 foot) level. During this period, approximately 1500 tons of ore were milled yielding 792 oz Au and 46 oz Ag at an average grade of 0.52 oz/ton Au and 0.03 oz/ton Ag (Assessment Files in Resident Geologist's Files, Ontario Ministry of Northern Development and Mines, Thunder Bay). The mine was subsequently inactive for some time.

In 1958, Gulch Mines Limited acquired the property from Maylac Gold Mines Limited and undertook dewatering of the shaft. Development work in the fourth level consisted of 402 feet of drifting and crosscutting as well as 13 diamond-drill holes totaling 1892 feet. A minor amount of diamond-drilling and resampling was also carried out on the upper three levels. Results of this work were discouraging and in 1959 the equipment was removed and the shaft sealed up. In 1974, Gulch Mines Limited changed the company name to Gulch Mines Incorporated and this was subsequently changed (1978) again to Gulch Resources Limited.

Geology

The mineralization occurs in a sequence of massive and pillowed mafic metavolcanics and associated gabbro with minor interflow chemical metasediments that are cut by diabase dikes. The mafic metavolcanics exhibit moderate to intense epidote alteration that characterizes mafic rocks in the central part of the Dionne Lake volcanic unit between Dionne and Hutal Lakes. Macdonald (1943, Figure 6)

presents a detailed map of the vicinity of the mine. Some of the outcrops mapped by Macdonald (1943) have since been overgrown and buried by fill during mine development and rerouting of Highway 584 and were not examined by the present survey. Macdonald's (1943) subdivision of the volcanic rocks into "tuff", "andesite", "coarse andesite or gabbro", "pillow lava", and "basic fragmental" reflects the range in primary structure (massive, pillowed, hyaloclastic brecciation), grain size (fine- to medium-grained) and degree of alteration of the basalts.

Where both bedding and foliation can be recognized together, these features are parallel. Quartz and epidote veining tend to be concordant with respect to foliation and the former is most commonly present in relatively highly sheared rocks.

Mineralization

Gold mineralization is associated with quartz veining that is concordant with respect to foliation and has adjacent sulphide-rich wall rock. The only vein that could be located during the present survey was that one on which most of the development work was concentrated. This vein is approximately 10 m west of the shaft in sheared, iron-stained mafic metavolcanics. The width of the vein is highly variable (10 to 20 cm) due to irregular pinching and swelling. A chip sample (2 m) across the quartz vein and adjacent iron-stained rock and grab sample of the quartz vein and sulphide-bearing wall rock collected by the author contained only traces of Au, Ag, Cu, Ni, Pb, and Zn (Geoscience Laboratories, Ontario Geological Survey, Toronto).

Macdonald (1943, p.16,17) described the mineralization as follows.

"The minerals present in the main veins on the property are quartz, ankerite, pyrite, pyrrhotite, sphalerite, chalcopyrite, galena, and gold. Quartz is the dominant vein mineral, but in some places sulphide mineralization is heavy. Mineralization has evidently taken place in two stages. Quartz, pyrite, and pyrrhotite were introduced in the first stage. This quartz is white and glassy in appearance. Pyrite is disseminated through it, and both are fractured. Some of the pyrite is partially replaced by later sulphide minerals. Pyrrhotite was introduced at the same time or slightly later than the pyrite, but it is much less common. A small amount of pyrite is later than the pyrrhotite and is thought to represent a late mineral of this early group.

The gangue minerals of the second stage of mineralization are quartz and ankerite. The quartz of this group is bluish in colour and markedly fractured. Sphalerite, chalcopyrite, galena, and gold fill the fractures of the quartz and replace earlier sulphides. Sphalerite and chalcopyrite are contemporaneous and are the early minerals of the second group. Galena is, at least in part, later than the sphalerite and chalcopyrite and is closely associated in time of deposition with the gold. Gold is the last mineral in the paragenetic sequence. It occurs in some specimens as coarse, easily visible blebs and has been observed in the following associations:—

1. In quartz gangue that is free from any visible fractures; or in fractures in quartz gangue, either with galena or alone.

2. In pyrite, sphalerite, and galena as blebs and veinlets.

3. Along contacts between sphalerite and quartz and penetrating the sphalerite.

These associations lead to the conclusion that the highest grade ore will be that which contains sphalerite, chalcopyrite, and galena. Since, however, gold occurs in fractured quartz free from sulphide, these minerals cannot be taken as direct indicators. In such cases the type of quartz is probably the best guide".

HUDSON BAY EXPLORATION AND DEVELOPMENT COMPANY LIMITED

Group E [1972] (16)

In 1972, Hudson Bay Exploration and Development Company Limited carried out a mineral exploration program on two separate claim groups in McQuesten Township.

One of these, referred to as Group E is located in north-central McQuesten Township near Highway 584. The second group is described later.

Work carried out on Group E includes geological mapping, ground geophysical surveys (EM and Mag), and diamond drilling. The area is underlain predominantly by fine- to medium-grained, foliated, amphibolitic, locally garnetiferous mafic metavolcanics. Ironstone, consisting of thinly bedded alterations of magnetite and chert is present in the western part of the group near Highway 584. Massive to disseminated pyrite is common in the iron formation. Minor felsic metavolcanics and quartz-feldspar porphyry are also present on the group.

Electromagnetic and magnetic anomalies coincide with the exposures of ironstone in the eastern part of the group. An analysis from a part of the ironstone containing massive and disseminated pyrite ran 0.1 percent Zn and traces of Cu, Au, and Ag (Assessment Files in Resident Geologist's Files, Ontario Ministry of Northern Development and Mines, Thunder Bay). Coincident electromagnetic and magnetic anomalies occur along strike in the northwestern part of the group but no exposures are present there and this zone was apparently not tested.

Two electromagnetically anomalous zones, without coincident magnetic anomalies, are present in the southern part of the claim group. This area is underlain by mafic metavolcanics, together with minor rhyolitic metavolcanics. Both of these zones were tested by diamond drilling and the anomalies are apparently related to the presence of sulphide-bearing graphitic shear zones. One 3-foot graphite schist zone from the southernmost anomaly contained 20 percent pyrrhotite and a trace of pyrite and ran 0.1 percent Cu, 0.1 percent Zn, and traces of Au and Ag (Assessment Files in Resident Geologist's Files, Ontario Ministry of Northern Development and Mines, Thunder Bay). Diamond drilling on the more northern anomaly encountered predominant mafic metavolcanics and subordinate rhyolite. The mafic metavolcanics on the south side of the rhyolite contain numerous graphitic shear zones with abundant pyrrhotite and pyrite and minor arsenopyrite and sphalerite. The best analysis from this hole ran 0.2 percent Zn, 0.1 percent Cu, and traces of Au and Ag over a width of 2.5 feet (Assessment Files in Resident Geologist's Files, Ontario Ministry of Northern Development and Mines, Thunder Bay).

Group M [1972] (17)

In 1972, Hudson Bay Exploration and Development Company Limited examined, in addition to that area discussed above, a second area referred to as Group M located in the northeastern part of McQuesten Township. An electromagnetic survey and diamond drilling were carried out on this claim group. Numerous electromagnetically anomalous zones were outlined by the electromagnetic survey and two of these were tested by diamond drilling. The property is underlain by mafic metavolcanics with subordinate ironstone (Macdonald 1943). One of these drillholes (M-1) encountered mafic metavolcanics with subordinate quartz-feldspar porphyry and a "lamprophyre" dike. Abundant massive, stringer and disseminated sulphide minerals (predominantly pyrrhotite and pyrite) are present but analysis results were generally poor with the best running 0.5 percent Zn, 0.1 percent Cu, and traces of Au and Ag over a width of 1 foot (Assessment Files in Resident Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay).

Diamond drilling of the second electromagnetically anomalous zone encountered mafic and rhyolitic metavolcanics and "lamprophyre" dikes. A 2-foot width of massive pyrrhotite contained only traces of Zn, Cu, Au, and Ag (Assessment Files in Resident Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay). Minor stringer and disseminated sulphide minerals (pyrrhotite, pyrite, chalcopyrite, arsenopyrite) are also present.

Diamond drilling on both Groups E and M satisfactorily explained the source of electromagnetic anomalies as massive to disseminated sulphide mineralization with or without associated graphite. Much of the sulphide mineralization is barren and assays of the best narrow zones were not sufficiently encouraging to justify further work. The claims were allowed to lapse.

KATERI MINING COMPANY LIMITED [1961] (18)

In May 1961, Kateri Mining Company Limited optioned 10 claims (TB100781 to 100790, inclusive) just north of Kirby Lake on which two mineralized shear zones were known to occur. This company subsequently contracted an airborne electromagnetic survey (July 1961) that covered much of Fulford and Kirby Townships. This survey led to the discovery of numerous electromagnetically anomalous zones in widely scattered areas in these two townships.

Subsequent to the electromagnetic survey, the company staked 10 additional claims (TB101021 to 101030, inclusive) adjoining those claims originally optioned. The Kirby Lake claim group is underlain predominantly by mafic metavolcanics with subordinate banded ironstone. Mineralization here is reported to consist of pyrite with minor sphalerite and chalcopyrite localized within shear zones.

The Clover Lake group comprises 16 contiguous claims (TB101420 to 101428 and 101708 to 10714, inclusive) situated northeast of Clover Lake. The airborne electromagnetic anomaly corresponds to a prominent ironstone horizon within mafic metavolcanics. A minor amount of disseminated sulphide mineralization is associated with the ironstone and a grab sample is reported to contain traces of gold (Assessment Files in Resident Geologist's Files, Ontario Ministry of Northern Development and Mines, Thunder Bay).

Claim groups at Brik Lake (TB101489 to 101491 and 101499 to 101500, inclusive), west Brik Lake (TB101719 to 101721, inclusive), south of Grenville Lake (TB101492 to 101498, inclusive), and Burrows River (TB101483 to 101488, inclusive), were also staked as a result of the airborne electromagnetic survey. No outcrop occurs on any of these claims but the areas lie near the inferred location of the southern contact of the Hutchison Lake metasedimentary belt, which further to the east is a fault.

Follow-up geological mapping, trenching, ground geophysics, and drilling were recommended but there is no record that any of this work was carried out. The claims were allowed to lapse but parts of the Kirby Lake group were subsequently restaked (see Canadian Nickel Company Limited-Kirby Lake, property number 5 and Joseph Oster, property number 25).

LAC-TECK GOLD MINES LIMITED [1938] (19)

In 1934, A. Rabideau staked 10 claims (TB19555 to 19556 and 17758 to 17765, inclusive) to the east of Dionne Lake and south of the Gulch Resources Limited (15) property. In 1936 these claims were acquired by Lac-Teck Gold Mines Limited. Three shallow shafts (44, 30, and 22 feet) were sunk and 20 feet of crosscutting were carried out at the 30-foot level as well as 900 feet of underground drilling. There is no information concerning the basis upon which this development work was undertaken. Surface exploration was carried out in 1937 to 1938 after which the company became inactive and the claims were allowed to lapse. The western part of the property was subsequenty investigated by Canadian Nickel Company Limited (8).

The property lies astride an inferred contact between fragmental felsic metavolcanics to the south and altered, massive and pillowed mafic flows to the north. Results of diamond drilling in the western part of the property (Canadian Nickel Company Limited-Dionne Lake, property number 8) and the presence of a weak aeromagnetic anomaly indicate that ironstone occurs at least intermittently along this contact. Macdonald (1943, p.18) reported that exploration work carried out by Lac-Teck Gold Mines Limited concentrated on quartz veins and sheared carbonatized zones. "A narrow quartz vein is present in the northeastern part of claim T.B.17,762. Andesite in the central part of claim T.B.17,758 contains a carbonate zone with a maximum width of 10 feet, which is, in part, sheared and rusted. Low gold values are reported from the carbonatized material."

LAKEHEAD GOLD MINES LIMITED [1939] (20)

Macdonald (1943, p.19) reported that Lakehead Gold Mines Limited held a property south of Papineau Lake in the vicinity of a major chert-magnetite ironstone horizon occurring in a sequence of massive and pillowed flows. There are no reports of the nature of the exploration activities carried out and the company became inactive and the claims were allowed to lapse.

LOUDON, DAOUST, McBURNIE GROUP [1939] (21)

Macdonald (1943) reported that 14 claims, referred to as the Loudon, Daoust, McBurnie group, situated approximately 3 km west of the shaft on the Gulch Resources Limited property (15), were held in the late 1930s. Macdonald (1943, p.18) reported: "Surface work and a small amount of diamond-drilling has been done. According to W. Loudon, of Geraldton, gold values up to $4.50 per ton (gold at $35.00) have been obtained from quartz veins in the sheared rocks." The claims were subsequently allowed to lapse.

There is little exposure in the vicinity of this property and the area is interpreted to be underlain predominantly by altered mafic flows similar to those observed on the Gulch Resources Limited property (15).

GEORGE MACINTOSH (GERALDTON LONG LAC GOLD MINES LIMITED) (22)

In 1982, George MacIntosh held six patented claims (TB14033 to 14038, inclusive) at the southwest end of Hutchison Lake. These claims include most of the area formerly held by Geraldton Long Lac Gold Mines Limited. Several adjacent claims formerly held by this company that lay entirely over the waters of Hutchison Lake have since reverted to the Crown.

In 1935, Geraldton Long Lac Gold Mines Limited acquired nine claims from Universal Exploration Syndicate who did not record any work on these claims. The former company carried out surface exploration in 1935 but then remained inactive for several years. In 1939, surface exploration resumed and approximately 2000 feet of diamond drilling were carried out. The next period of activity occurred in 1944 when diamond drilling reportedly resumed. There is no record of any subsequent mineral exploration carried out on this property. Trenches are exposed on the south shore of Hutchison Lake but it is not known when this work was carried out.

Few exposures occur on the property but the Burrows River Fault, separating the Hutchison Lake metasedimentary belt from the metavolcanics to the south, is inferred to pass through the property. Exposures on the south shore of Hutchison Lake are wacke with numerous highly sheared zones. The sheared areas are commonly iron-stained and have quartz veining and some of these have been investigated by trenching. Analyses of grab samples collected by the author from a quartz vein and rusty, magnetite-bearing wacke and two chip samples across rusty zones ran only traces of Au, Ag, Cu, Ni, Pb, and Zn (Geoscience Laboratories, Ontario Geological Survey, Toronto). Outcrops in the southeastern part of the property near the runway of the Geraldton airport are massive and pillowed mafic flows that do not display the intense alteration characteristics of those to the south in the vicinity of the Gulch Resources Limited property (15).

Macdonald (1943, p.17) reported that mineralization occurs as follows. "One shear zone in the extreme southern part of claim T.B. 14,040 has been mineralized with pyrite and pyrrhotite. Diamond-drilling in the southern part of claim T.B. 14,034 has shown the presence of andesite and tuff. Although small intersections of gold-bearing veins were obtained in the tuffs, the results were evidently not sufficiently encouraging to follow up."

McLELLAN LONG LAC GOLD MINES LIMITED [1938] (23)

In 1937, McLellan Long Lac Gold Mines Limited acquired a group of claims situated approximately 1.5 km north of the west end of Dionne Lake. Surface exploration, including trenching, was carried out in 1937 to 1938 and the claims were subse-

quently cancelled. Parts of the area have been intermittently staked by various people but no further work has been recorded.

The limited outcrop in the vicinity of this area consists of massive, altered mafic flows. These outcrops are the westernmost of those that display conspicuous epidotization.

No veining or mineralization were noted in this area by the present survey although numerous overgrown trenches were located. Macdonald (1943, p.17,18) described the mineralization as follows.

> "The showing, situated on claim T.B. 19,736, consists of a moderately sheared carbonate zone in andesite. The shear zone contains narrow quartz stringers over a maximum width of 10 feet and is exposed in a trench for 200 feet. The wall rock contains disseminated pyrite and ankerite; the quartz veins contain pyrite, pyrrhotite, galena, ankerite, and tourmaline. One 3-inch quartz vein is much more heavily mineralized than the other veinlets. A similar carbonate shear zone occurs in a pit 450 feet west of the trench. Quartz veinlets are present over a width of 4 feet. The largest one, which is 8 inches wide, shows two ages of quartz, an early white quartz and a late blue quartz. The same minerals as those in the trench to the east are present, but the mineralization is irregular and sparse."
>
> The claims were allowed to lapse.

NIPILAC GOLDFIELDS LIMITED [1939] (24)

Between 1937 and 1939, Nipilac Goldfields Limited held nine claims (TB15506 to 15514, inclusive) just to the east of the Gulch Resources Limited property (15). Macdonald (1943) reported that surface exploration and diamond drilling were carried out in an attempt to locate an eastward continuation of the veins on the adjacent property. Apparently only narrow quartz veins and low gold values were intersected. The main rock type underlying the property is altered, massive mafic flows similar to those on the Gulch Resources Limited property. Several diabase dikes intrude the basalt. Parts of this property were subsequently staked by various people but no further work was recorded and the ground is presently not held.

JOSEPH OSTER (25)

In 1982, Joseph Oster held four contiguous claims (TB603678 to 603681, inclusive) in central Kirby Township. Parts of this area have been repeatedly staked in the past. In 1955, Neil Smith carried out stripping and trenching that exposed two showings. One of these showings consisted of abundant (>25 percent) pyrite with minor chalcopyrite associated with a sheared quartz vein. The other showing, situated approximately 100 m east of the cabin on Kirby Lake, is referred to as a sheared zone with narrow, pyritic sulphide mineralization zones and sugary quartz with minor sphalerite.

The claims were cancelled and, in 1961, N.H. Black restaked the area (total of 10 claims) and subsequently optioned the ground to Kateri Mining Company Limited (18). This company subsequently carried out an airborne electromagnetic survey over much of Fulford and Kirby Townships that led to the staking of claims in several areas including 10 further claims adjacent to those optioned from Black. This company concluded the mineralization was non-economic and terminated the option agreement. In 1962 the claims were cancelled.

In 1969, Canadian Nickel Company Limited (5) held a group of claims that partially overlaps the area presently held by Joseph Oster. This company, drilled two diamond-drill holes, one approximately 100 m north and the other approximately 600 m east, of the northeast corner of Oster's claims. Both drillholes intersected mafic metavolcanics with minor chert-magnetite ironstone. The claims were cancelled in 1971.

From 1979 to the present, Joseph Oster has carried out limited further trenching in the vicinity of the showing 100 m west of the cabin.

The present survey was able to locate only that showing recently worked by Oster. A narrow (<30 cm) concordant mineralized zone is spatially associated with a cherty horizon within massive and pillowed basaltic lava. No magnetite or hematite were noted but this cherty unit is undoubtedly genetically related to the chert-magnetite ironstone horizon that is interpreted to be 100 to 200 m north of this showing. Sulphide minerals present include minor sphalerite, galena, and pyrite. Analysis results for a 1 m chip sample across the mineralized zone, collected by the author indicates the following abundances: Cu-0.01 percent, Pb-0.26 percent, Ni-0.01 percent, Zn-0.32 percent, Au-trace, Ag-0.52 oz/ton (Geoscience Laboratories, Ontario Geological Survey, Toronto).

J. PICHETTE [1952] (26)

In 1952, J. Pitchette drilled four diamond-drill holes (total of 246 feet) on claim TB42506 situated in central McQuesten Township. The precise location of these drillholes within the claim is not known. Pichette reported narrow zones of high-grade mineralization associated with quartz veins. The best analysis reported has 6.7 percent Zn, 0.76 oz/ton Ag, and 0.06 oz/ton Au over a width of 1 foot (Assessment Files in Resident Geologist's Files, Ontario Ministry of Northern Development and Mines, Thunder Bay). Outcrops in the vicinity of this claim are massive and pillowed mafic flows. The claims were allowed to lapse.

UNIVERSAL EXPLORATION (1937) LIMITED [1939] (27)

In 1939, Universal Exploration (1937) Limited acquired a property south of Papineau Lake and near the property of Lakehead Gold Mines Limited (20). The area is interpreted to be underlain predominantly by massive and pillowed mafic flows with minor chert-magnetite ironstone. There is no record of exploration and development work and the claims were allowed to lapse.

References

Ayres, L.D.
1969: Early Precambrian Stratigraphy of Part of Lake Superior Provincial Park, Ontario, Canada, and its Implications for the Origin of the Superior Province; unpublished Ph.D. thesis, Princeton University, Princeton, New Jersey.

Beakhouse, G.P.
1983: Geological, Geochemical and Rb-Sr and U-Pb Zircon Geochronological Investigations of Granitoid Rocks from the Winnipeg River Belt, Northwestern Ontario and Southeastern Manitoba; unpublished Ph.D. thesis, McMaster University, Hamilton, Ontario.

Beakhouse, B.P., and Chevalier, P.
1983a: Precambrian Geology of Fulford and McQuesten Townships, Thunder Bay District; Ontario Geological Survey, Map P.2593, Geological Series-Preliminary Map, scale 1:15 840 or 1 inch to 1/4 mile. Geology 1982.
1983b: Precambrian Geology of Kirby Township, Thunder Bay District; Ontario Geological Survey, Map P.2592, Geological Series-Preliminary Map, scale 1:15 840 or 1 inch to 1/4 mile. Geology 1982.

Blatt, H., Middleton, G., and Murray, R.
1972: Origin of Sedimentary Rocks; Prentice-Hall, Englewood Cliffs, New Jersey, 634p.

Bruce, E.L.
1935: Little Long Lac Gold Area; Ontario Department of Mines Annual Report, Volume 44, Part 3, 60p. Accompanied by Map 44D, scale 1/2 mile to the inch.

Burrows, A.G.
1917: Longuelac to Jellicoe and Orient Bay; Ontario Bureau of Mines Annual Report, Volume 26, Part 1, p.227-247. Accompanied by Map 25, scale 2 miles to the inch or 1:126 720.

Callander, R.M.
1970: Windigokan Conglomerate; unpublished B.Sc. thesis, University of Waterloo, Waterloo, Ontario, 89p.

Canadian Mining Journal
1939: Provincial News, Ontario; Canadian Mining Journal, Volume 60, Number 7, July 1939, p.448.

Dimroth, E.
1977: Archean Subaqueous Autoclastic Volcanic Rocks, Rouyn-Noranda Area, Quebec: Classification, Diagnosis and Interpretation; Geological Survey of Canada, Paper 77-1A, p.513-522.

Donaldson, J.A., and Jackson, G.D.
1965: Archean Sedimentary Rocks of the North Spirit Lake Area, Northwestern Ontario; Canadian Journal of Earth Sciences, Volume 2, p.622-647.

Fisher, R.V.
1966: Rocks Composed of Volcanic Fragments and their Classification; Earth Science Reviews, 1, p.287-298.

Gartner, J.F.
1979: Jellicoe Area, District of Thunder Bay; Ontario Geological Survey, Northern Ontario Engineering Geology Terrain Study 27, 16p. Accompanied by Map 5060, scale 1:100 000.

Gross, G.A.
1965: General Geology of Evaluation of Iron Deposits; Volume I, 165p. *in* Geology of Iron Deposits in Canada, Geological Survey of Canada, Economic Geology Report 22, 3 volumes. Accompanied by maps.

Grunsky, E.C.
1981: An Algorithm for the Classification of Subalkalic Volcanic Rocks Using the Jensen Cation Plot; p.61-65 *in* Summary of Field Work, 1981, by the Ontario Geological Survey, edited by John Wood, O.L. White, R.B. Barlow, and A.C. Colvine, Ontario Geological Survey, Miscellaneous Paper 100, 255p.

Horwood, H.C., and Pye, E.G.
1955: Geology of Ashmore Township; Ontario Department of Mines, Annual Report for 1951, Volume 60, Part 5, 105p. Accompanied by Map No. 1951-2, scale 1 inch to 1000 feet.

Irvine, T.N., and Baragar, W.R.A.
1971: A Guide to the Chemical Classification of the Common Volcanic Rocks; Canadian Journal of Earth Sciences, Volume 8, Number 5, p.523-548.

Jensen, L.S.
1976: A New Cation Plot for Classifying Subalkalic Volcanic Rocks; Ontario Division of Mines, Miscellaneous Paper 66, 22p.

Macdonald, R.D.
1943: Geology of the Hutchison Lake Area; Ontario Department of Mines, Annual Report for 1941, Volume 50, Part 3, p.1-21. Accompanied by Map 50f, scale 1:63 360.

Mackasey, W.O.
1970a: Eva Township, District of Thunder Bay; Ontario Department of Mines, Preliminary Map P.601, scale 1:15?840 or 1 inch to 1/4 mile. Geology 1969.
1970b: Summers Township, District of Thunder Bay; Ontario Department of Mines, Preliminary Map P.602, scale 1:15?840 or 1 inch to 1/4 mile. Geology 1969.
1974: Lapierre and Hipel Townships, District of Thunder Bay; p.70-73 *in* Summary of Field Work, 1974 by the Geological Branch, edited by V.G. Milne, D.F. Hewitt and K.D. Card, Ontario Division of Mines, Miscellaneous Paper 59, 206p. ?5>1975: Geology of Dorothea, Sandra, and Irwin Townships, District of Thunder Bay; Ontario Division of Mines, Geological Report 122, 83p. Accompanied by Map 2294, scale 1 inch to 1/2 mile.
1976: Geology of Walters and Leduc Townships, District of Thunder Bay; Ontario Division of Mines, Geological Report 149, 58p. Accompanied by Map 2356, scale 1 inch to 1/2 mile.

Mackasey, W.O., Edwards, G.R., and Cape, D.F.
1976a: Legault Township, District of Thunder Bay; Ontario Division of Mines, Preliminary Map P.1191, Geological Series, scale 1:15 840 or 1 inch to 1/4 mile. Geology 1973.
1976b: Colter Township, District of Thunder Bay; Ontario Division of Mines, Preliminary Map P.1192, Geological Series, scale 1:15 840 or 1 inch to 1/4 mile. Geology 1973.

Miall, A.D.
1977: A Review of the Braided-River Depositional Environment; Earth Science Reviews, 13, 1-62.

Northern Miner Press Limited
1937: Canadian Mines Handbook 1937; Northern Miner Press Limited, Toronto, 383p.

Ontario Division of Mines-Geological Survey of Canada
1974a: 42 E/15c Sheet; Ontario Division of Mines-Geological Survey of Canada, Aeromagentic Series, Map 20,077G, scale 1:25 000. Survey flown August 1971.
1974b: 42 E/15d Sheet; Ontario Division of Mines-Geological Survey of Canada, Aeromagnetic Series, Map 20,081G, scale 1:25 000. Survey flown August 1971.
1974c: 42 E/14a Sheet; Ontario Division of Mines-Geological Survey of Canada, Aeromagentic Series, Map 20,085G, scale 1:25 000. Survey flown August 1971.
1974d: 42 E/14b Sheet; Ontario Division of Mines-Geological Survey of Canada, Aeromagentic Series, Map 20,089G, scale 1:25 000. Survey flown August 1971.

Pye, E.G.
1952: Geology of Errington Township, Little Long Lac Area; Ontario Department of Mines, Annual Report for 1951, Volume 60, Part 6, 140p. Accompanied by Map 1951-7, scale 1 inch to 1000 feet.

Pye, E.G., Harris, F.R., Fenwick, K.G., and Baillie, J.
1966: Geraldton-Tashota Sheet, Districts of Thunder Bay and Cochrane; Ontario Department of Mines, Geological Compilation Series, Map 2102, scale 1:253 440 or 1 inch to 4 miles. Compilation 1965.

Rust, B.R.
1979: Coarse Alluvial Deposits; p.9-21 *in* Facies Models, edited by R.G. Walker, Geoscience Canada Reprint Series 1, 211p.

Sangster, D.F.
1972: Precambrian Volcanogenic Massive Sulphide Deposits in Canada: A Review; Geological Survey of Canada, Paper 72-22, 44p.

Swanson, S.E.
1977: Relation of Nucleation and Cryptal-Growth Rate to the Development of Granitic Textures; American Mineralogist, Volume 62, p.966-978.

Walker, R.G.
1979: Turbidites and Associated Coarse Clastic Deposits; p.91-103 *in*Facies Models, edited by R.G. Walker, Geoscience Canada Reprint Series 1, 211p

Wood, J.
1980: Geology of the Hewitt Lake Area, District of Kenora, Patricia Portion; Ontario Geological Survey Report 186, 122p. Accompanied by Map 2408, scale 1:31 680 (1 inch to 1/2 mile).

Zoltai, S.C.
1967: Glacial Features of the North-Central Lake Superior Region; Canadian Journal of Earth Sciences, Volume 4, p.515-528.

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